博士論文

The dissertation for Phd degree of the University of Tokyo

Research on the Framework of the Global Maritime Transport Indices in the Big Data Era

（ビッグデータ時代におけるグローバル海運指数の構造に関する研究）

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Thanks

After the tsunami attack and in the nuclear radiation of Fukushima accident in Spring 2011, I came to Kashiwa Campus of the University of Tokyo, started my study and research in Japan. After 6 years, I have studied all of my courses and almost finish my phd thesis in the Autunm 2016. At this time, I must write some words to share my feeling with the readers of this paper.

Research is a kind of boring work when no idea to find the problem interested and its solution. It is also be a kind of exciting work when the solution is found. Insisting on reading is very important when no way to go. The wisdom of predecessors always brings surprising enlightenment. The encouragement from supervisor, teachers, friends and family is particularly precious at that time. So, first thanks is to Professor Tatsuo Yanagita 柳田辰雄, my supervisor. Without your kindly support and guide, I cannot finish the paper on time. Second thanks is to my wife and daughter, you never disturb me when I was reading the references and writing the paper. I had no time to accompany you to buy your clothes during these five years. Third thanks is to my colleague in Shanghai Jiao Tong University, especially to Professor JI Jianhua 季建華，Professor ZHU Daoli 朱道立 and Professor ZHU Qinghua 朱慶華, you were my powerful backing on work when I was in Japan. Fourth thanks to my lab mates WAN Yi 萬毅, YANG Dongming 杨東明 and others. You gave me so many help when I live in Tokyo.

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And I have to say thanks to Mr. Chris Hughes, the deputy manager of the market department in Great China Area of Lloyd‘s Register. This paper can be read and understand easily based on your careful check for the spelling and grammar.

Time always passed so quickly. After six years, I had learned not only the methodology of research, but also the opinion of globalization. I listened and discussed the global issues with classmates and faculties from different countries, especially in the department of international study, Graduate School of Frontier Sciences. This will strongly support my further research in China. China needs more and more global view research on economics and management science.

Last and very important, I feel deeply the friendship from Japanese people. I cannot say Japanese very well. But I never feel inconvenience when I was in Japan. Salesmen in stores, ticket men in train stations and strangers on road always gave me smile and help when I felt confusing.

Kashiwa, Ginkgo and Sakura, I love you.

Synopsis

With the development of communication technology, the big data became a hot topic in the world. Many new concepts appear not only on internet but also in research papers like as e-business platform, internet plus, big data, smart society or smart city, etc. UN Global Pulse handles many projects to promote big data technology. The Whitehouse of US announced a “Big Data Research and Development Initiative”. The governments of UK, Australia, Japan and China also took their actions in this area. Some think tanks as IBM, Oracle. PwC, etc. are making research and development of big data products for public service and business.

The global maritime transport industry carries over 80 percentage of international trade goods among people and communities all over the world. Waterborne transport is the most efficient and cost-effective method of goods transportation, providing a dependable, low-cost means of transporting goods globally, facilitating commerce and helping to create prosperity among nations and peoples. The prosperity of global economy is strongly related with the development of global maritime transportation market. The bulk market, the tanker market and the container liner market are the three main sub-markets of the global maritime transport market. Each of them has the special regular pattern. So the BDI, the Clarksea Index and the CCFI, etc. are developed. But they are not enough.

Based on the market structure analysis and economic index theory, this paper outlined the indices framework of the global maritime transport market that includes three series of indices: the prosperity index, freight index and earning index. The prosperity index illustrates the investment value of the market, and the freight index indicates freight rate change of the market, earning index show the possibility of the market. We believe that not only the whole maritime transport market needs a prosperity index, but also the bulk market, tanker market, liner market, etc. need their prosperity index as their asynchronization. Meanwhile, as the shortage of data sources, there is not a global container liner freight in the market. The aim of this research is to find the ways to set up the prosperity index for global maritime transport market and the global container liner freight index.

After researching on the plenty results of the NBER and many economists on business cycle indices, compared with the character of global maritime transport market, the Prosperity Index of the Global Maritime Transport Market (PIGMT) can be calculated with the data set of international trade indicators, freight indices, fuel price indices, capacity of fleet. Collecting the many data of 27 indicators from January 2000 to December 2015, changing them to monthly data, putting them in the equations in the algorithm, the PIGMT for 16 years was born. Compared with the actual situation of the large scale shipping companies, the PIGMT can be recognized to reflect the company's profitability.

Based on a comparative analysis with the existing container freight indices, the method of integrating the framework with the use of data from e-booking platforms and illustrate the reason that the new index can provide more insightful information for shippers. This framework can be applied to have a daily Shanghai container freight index by combining data sources from the platforms linked to the Shanghai port. By implementing the index to a risk analysis problem,

numerical results can be used to show the Daily Container Freight Index (DCFI) potential position in real investments for container liner markets.

The key points of this paper are: ⑴The global maritime transport market is borderless. So every investment in this market is borderless. Investors just concern the global index but local index. Local freight index is only useful for shippers and carriers in local market. ⑵For investor, the profit of company is more important than revenue. So the prosperity index can give the situation more correctly than freight index for investor as the freight rate just indicate the revenue of shipping company but cost. ⑶The business cycle theory can be used in global maritime transport market as it also is a cycle market. ⑷The PIGMT can be created by composite index method. ⑸With the action of the big data strategy plan, more and more freight indices can be created as the DCFI. In big data era, the PIGMT will be more accurate.

Main contributions of this paper are: ⑴Proved only freight index is not enough for investors, prosperity index is needed in global maritime transport market. ⑵Designed the framework of data products of the global maritime transport market. ⑶Designed the algorithm of the PIGMT according to the methodology of business cycle index, and tested its correction. The result is reliability. ⑷Designed the algorithm of the DCFI based on e-booking platform.

Key Words: prosperity indices, freight index, global economy, maritime transport, business cycle

Abbreviations

3PL	Third Party Logistics
40HQ	40 feet high cube
AHP	Analytic Hierarchy Process
BAF	Bunker Adjustment Factor
BCI	Baltic Capesize Index
BDI	Baltic Dry Index
BDTI	Baltic Dirty Tanker Index
BE	Baltic Exchange
BHP	Broken Hill Proprietary Billiton Ltd.
BIMCO	Baltic International Maritime Committee
BLP	Bloomberg Limited Partnership
BPI	Baltic Panamax Index
CAF	Currency Adjustment Factor
CCFI	China Container Freight Index
CCIEE	China Center for International Economic Exchanges
CEMAC	China Economic Monitoring & Analysis Center
CFS	Container Freight Station
CRS	Clarkson Research Service Ltd.
CTI	Container Throughput Index
DCFI	Daily Container Freight Index
FEU	Forty feet Equivalent Unit
FFA	Forward Freight Agreements
FPI	Food Price Index
GDP	Gross Domestic Product
GNP	Gross Nation Products
GP container	The container for general purpose
GPS	Global Positioning System
HR	Howe Robinson：a UK-based ship broker
HSBC	The Hongkong and Shanghai Banking Corporation
IACS	International Association of Classification Societies
IBM	International Business Machines Corporation
ICAP	Inter-capital：a UK-based leading markets operator and provider of post trade risk mitigation and information services
ICE	Intercontinental Exchange
ICT	Information & Communications Technology
IEI	International Economic Indicator System
INMASAT	International Maritime Satellite Organization
KG	Kommandit Gesellschaft (one of Germany Shipping Funding)
LNG	Liquefied Natural Gas

MTO	Multimodal Transport Operator
NBER	the National Bureau of Economic Research
NSA	Nikkei Stock Average
NSC	Nippon Steel Corporation
NVOCC	Non-Vessel Operating Common Carrier
NYK	Nippon Yusen Kaisha
NYMEX	New York Mercantile Exchange
OECD	Organization for Economic Co-operation and Development
P & I	Protection and indemnity
PCS	Port Congestion Surcharge
RBS	Royal Bank of Scotland
RWI	Leibniz-Institut für Wirtschaftsforschung
SAS	Statistical Analysis System
SCFI	Shanghai Container Freight Index
SSE	Shanghai Shipping Exchange
SSY	Simpson Spence & Young Shipbrokers
TEU	Twenty feet Equivalent Unit
THC	Terminal Handling Charge
UBSR	Utility-based Shortfall Risk
WS	World Scale
WTI	West Texas Intermediate

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“The hope is that as you take the economic pulse in real time, you will be able to respond to anomalies more quickly.”

—Hal Varian,
Google Chief Economist
Professor Emeritus (University of California, Berkeley)

Chapter 1 Introduction

Typing "big data" into search box on webpage of ScienceDirect, it can be found that there are many research papers with this keyword since 1997. The number was over 10 thousands in 2000, over 30 thousands in 2013, was 52900 in 2015. "Big data" has already become one of the hottest topic not only in academia, but also in business community. This study focus on the application potential of "big data" in the global maritime transport business.

1.1 The concept of big data

1.1.1 Expert opinions

The big data of course bases on huge number of data including digital. But huge number is not the prerequisite of the big data. Facing over hundreds of gigabytes of data from mobile devices, software logs, digital cameras, digital video, microphones, radio-frequency identification (RFID) readers and wireless sensor networks, people build data warehouse (for example: Internet Data Center) to store and try to use them to develop various data products and business intelligences. Many institutes and specialists try to describe their understanding about big data. Some examples are as follows:

Mitch Waldrop (2008) wrote: "Scientist-edited interactive 'wiki'-type websites have proliferated over the past years, to the point where researchers have begun to joke about the new science of 'wikiomics'. All the sites are modelled on the popular user-edited, online encyclopedia Wikipedia. Experts should turn the data flooding into the large public databases into useful knowledge."

Professor Viktor Mayer-Schönberger and Kenneth Cukier (2012) wrote: not a random sample, but all data, not accurate, but mixed, not causation, but correlation, these three sentences could be recognized as the characteristic of big data.

IBM listed this sentence on its website: Big data is being generated by everything around us at all times. Every digital process and social media exchange produces it. Systems, sensors and mobile devices transmit it. Big data is arriving from multiple sources at an alarming velocity, volume and variety. To extract meaningful value from big data, you need optimal processing power, analytic capabilities and skills[1].

SAS gave its words like that：Big data is a term that describes the large volume of data – both structured and unstructured – that inundates a business on a day-to-day basis. But it's not the amount of data that's important. It's what organizations do with the data that matters. Big data can be analyzed for insights that lead to better decisions and strategic business moves[2].

Oracle gave 4Vs as the characteristics of big data: ⑴Volume. Big data requires processing high volumes of low-density, unstructured Hadoop data. It is the task of big data to convert such Hadoop data into valuable information. ⑵Velocity. The highest velocity data normally streams directly into memory versus being written to disk. ⑶Variety. Unstructured and semi-structured

[1] http://www.ibm.com/big-data/us/en/
[2] http://www.sas.com/en_us/insights/big-data/what-is-big-data.html

data types, such as text, audio, and video require additional processing to both derive meaning and the supporting metadata. ⑷Value. There are a range of quantitative and investigative techniques to derive value from data. The real challenge is learning to ask the right questions, recognizing patterns, making assumptions, and predicting behavior.[3]

McKinsey Global Institute said: Big data will become a key basis of competition, underpinning new waves of productivity growth, innovation, and consumer surplus— as long as the right policies and enablers are in place. Leaders in every sector will have to grapple with the implications of big data, not just a few data-oriented managers. The increasing volume and detail of information captured by enterprises, the rise of multimedia, social media, and the Internet of Things will fuel exponential growth in data for the foreseeable future[4].

PricewaterhouseCoopers（PwC）(2014) described big data as data lake and define the data lake with four criteria: ⑴Size and low cost: Data lakes can be an order of magnitude less expensive on a per-terabyte basis to set up and maintain that data warehouse. ⑵Fidelity: Hadoop data lakes preserve data in its original form and capture changes to data and contextual semantics throughout the data lifecycle. ⑶Ease of accessibility: Whether structured, unstructured, or semi-structured, data is loaded and stored as is to be transformed later in data lake. ⑷Late binding: Hadoop lends itself to flexible, task-oriented structuring and does not require up-front data models.

Since 2012, the Institute of Electrical and Electronics Engineers (IEEE) holds the Big Data Congress every year supported by IBM, SAS, GOOGLE, ORACLE and Microsoft. They believe the Big Data Congress will be an international forum that formally explores various business insights of all kinds of value-added services. Big Data is a key enabler of exploring business insights and economics of services.

1.1.2 Government actions

In May 2012, UN Global Pulse, the initiative based in the Executive Office of the Secretary-General United Nation, published a paper named “Big Data for Development: Challenges and Opportunities”. The vision of UN Global Pulse is a future in which big data is harnessed safely and responsibly as a public good[5]. UN Global Pulse handles many big data projects, and believes that big data represents a new, renewable natural resource with the potential to revolutionize sustainable development and humanitarian practice.

Meanwhile, some governments set up their strategy plans of big data. The typical samples are as follows.

⑴United State of America

In 2009, US government set up the website-www.data.gov to share the government data and data analysis tool with public. After three years, in March 2012, the Obama Administration announced a “Big Data Research and Development Initiative to help solve some the Nation’s most pressing challenges by improving the ability to extract knowledge and insights from large and complex collections of digital data.

[3] https://www.oracle.com/big-data/index.html

[4] http://www.mckinsey.com/business-functions/business-technology/our-insights/big-data-the-next-frontier-for-innovation

[5] http://unglobalpulse.org/about-new

To launch the initiative, the National Science Foundation, the National Institutes of Health, the Department of Defense, the Department of Energy and the US Geological Survey announced together more than $200 million funding in new commitments that promise to greatly improve the tools and techniques needed to access, organize, and glean discoveries from huge volumes of digital data.

The Federal Government has built the Intelligence Community Comprehensive National Cybersecurity Initiative Data Center in Utah for many years. It is a data storage facility designed to store data estimated to be on the order of exabytes or larger.

⑵ United Kingdom

Following US, the Department for Business, Innovation & Skills (BIS) of UK set up the Data Strategy Board (DSB) in July 2012. Main tasks of DSB are to promote data open, to develop data source, to provide the valuable data for public and to promote economy growth by business value of big data. In January 2013, UK Science and Universities Minister David Willetts announced the investment plan on the programs of science research and innovation. These programs included "eight great technologies" that were identified as the propellers which can push the economy in next 20 years. The first one is "the big data revolution and energy-efficiency computing" which was planned to have ￡189 million research and development funding.

The United Kingdom Government is taking a series of actions to enhance investment on the technical R＆D, to set up robust basic database, and to insist the open access of data.

⑶ Japan

Japan government set up the Global ICT[6] Strategy Bureau(GISB) under the Ministry of Internal Affairs and Communication(MIC) in July 2008. In order to develop comprehensive and strategic policies in the ICT field from a global perspective, GISB promotes research and development, standardization activities, and overseas deployment activities in this field in the context of strengthening international competitiveness in a coordinated manner.

Based on the work of the GISB, MIC has prioritized "ICT Growth Strategy II" as domestic strategy, and "Initiative on Intensification of international Competitiveness and Global Outreach in the Field of ICT" as international strategy. Finally, "Smart Japan ICT Strategy", which is comprised of these two strategies, was announced in June 2014. Fig.1-1 gives the scheduled plan of the strategy.

⑷ Australia

In June 2013, the Department of Finance and Deregulation, Australian Government Information Office published "Australia Public Service Big Data Strategy". This draft introduced the concept of big data, described the opportunities and benefits of big data strategy, announced the strategy vision, principles and actions. The principles are: Data sets that government holds are a national asset and should be used by public goods; Big data projects will incorporate 'privacy by design'; Data integrity and transparency of the process must be guaranteed; Skill and expertise in data analytics will be shared amongst government agencies and industry where appropriate; The industry, research and academic sectors have been working on big data analytics projects for some time and continue to invest heavily in the skills, technologies and techniques involved with big

[6] Information & Communications Technology

data analysis.

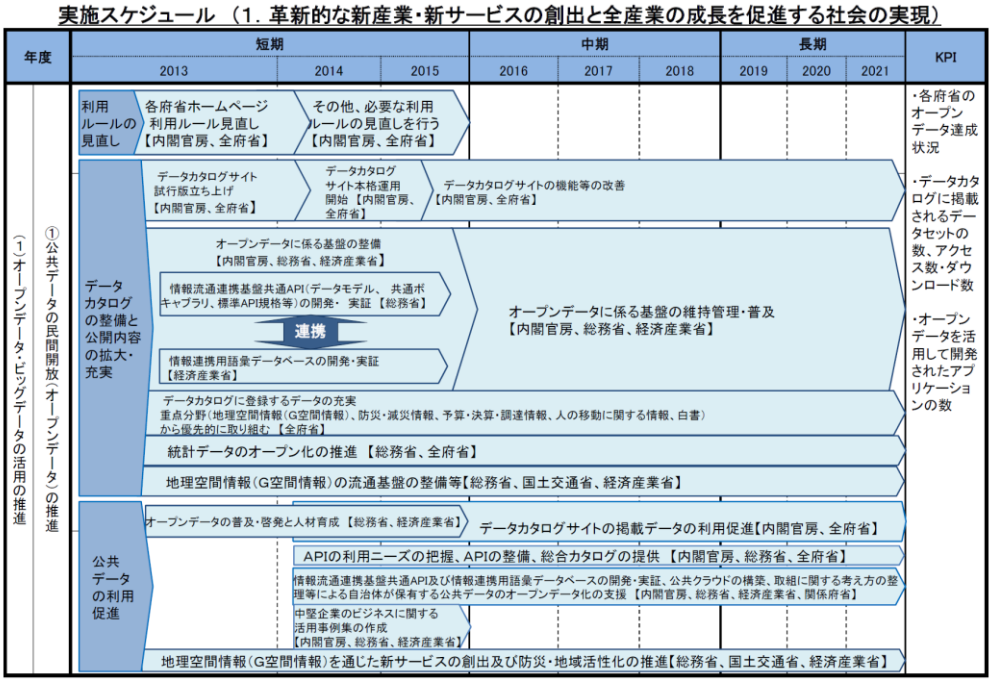


Fig.1-1 The scheduled plan of "Smart Japan ICT Strategy"[7]

⑸ China

In May 2011, the State Council of the People's Republic of China(PRC) set up the Cyberspace Administration of China(CAC) to enhance the internet security administration with the rapid growth in the number of Internet users in China. In February 2014, the Central Committee of the Communist Party of China set up the Office of the Central Leading Group for Cyberspace Affairs(OCGCA). The head of OCGCA is XI Jinping, the President of PRC. The responsibilities of OCGCA are the construction of internet in China, the security on internet, the promotion of internet economy and the removal of false information. In March 2015, Premier LI Keqiang said that the central government would make the action plan of internet plus of China in his annual government work report. In November 2015, the big data strategy was listed in the draft of 13th Five-year Plan for National Economic and Social Development. The main idea is to promote the economy restructuring with big data.

The Cyberspace Administration of China and Zhejiang Provincial People's government held the first World Internet Conference(WIC) in the town of Wuzhen, Zhejiang province, Nov 19-21, 2014, which attracted prominent Internet figures from nearly 100 countries. This was China's first Internet conference of this kind and on this scale and an unparalleled event globally. Since then, the WIC will be held at the same town every year. In WIC 2015, the organization committee published Wuzhen Initiatives as follows: ⑴Imperative to promote Internet deployment and development, ⑵Fostering cultural diversity in the cyberspace, ⑶Sharing the fruits of the Internet development, ⑷Ensuring peace and security in cyberspace, ⑸Improving the global Internet governance.[8]

[7] www.kantei.go.jp/jp/singi/it2/kettei/pdf/.../siryou3.pdf
[8] http://www.wuzhenwic.org/2015-12/18/c_48241.htm

1.2 The world economy and maritime transport in big data era

Global economic data analysis is the very important work for investors in maritime transport market because this market has so broad and deep relationship with world economy and international trade. There are 232 economies on the earth, 188 of them own their coast now. So maritime transport is an important business for most of economies. As ocean covers over 70% surface of the earth, since the first cargoes were moved by sea more than 5,000 years ago, it has been at the forefront of global development. Maritime transport has been an important human activity throughout history, particularly where prosperity depended primarily on international and interregional trade. Now around 80% of global trade by volume and over 70% by value is carried by vessel and is handled by ports worldwide. So, the data analysis in maritime transport market faces a big data set which includes world economy, vessel supply, international trade, international politics even weather changes.

The maritime transport market is typically a global market in most situation. Many international organizations set up their databases with maritime transport data, like United Nations Conference of Trade and Development(UNCTAD), Organization for Economic Co-operation and Development(OECD), World Trade Organization(WTO), etc. Of course, the specialized organizations like the International Chamber of Commerce(ICC)，the International Maritime Organization (IMO), the World Custom Organization(WCO) have set their big data sets with the massive and detailed maritime information.

UNCTAD gave the OECD Industrial Production Index and indices for world GDP, world merchandise trade and world seaborne trade (1975-2014) (1990=100) as shown in Fig.1-2.

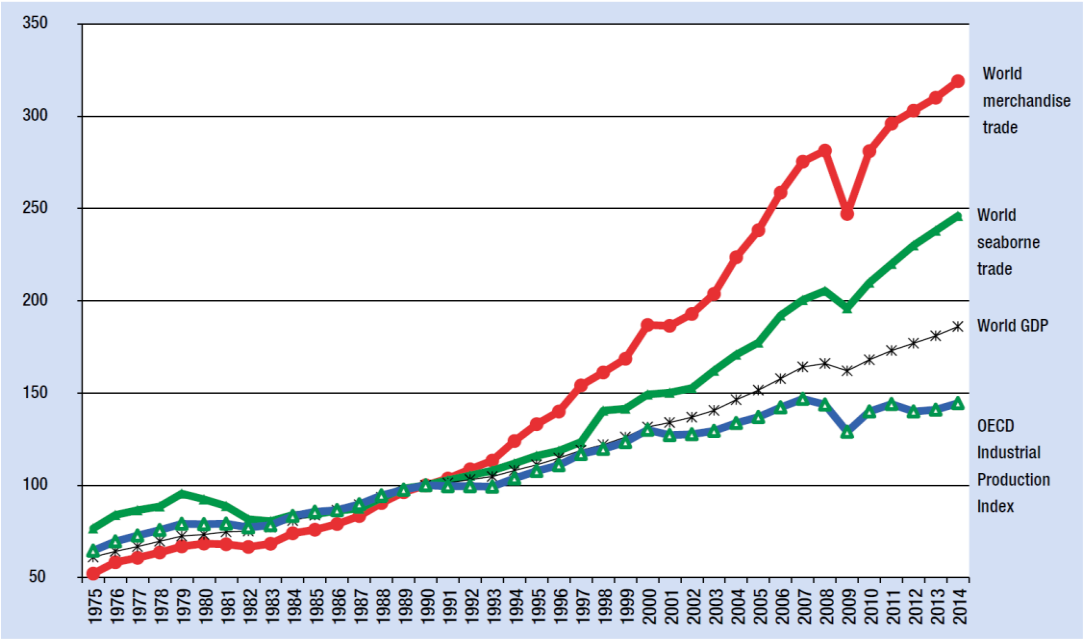


Fig.1-2 World economy and seaborne trade[9]

Therefore, the correlation between maritime transport industry and world economy can be described as follows:

[9] The OECD Industrial Production Index and indices for world GDP, merchandise trade and seaborne shipments (1975–2014) (base year 1990 = 100). Data source: UNCTAD. 2015, Maritime Transport Review 2015

⑴ The development of world economy gives huge demand to global maritime transport industry

As international trade and division of labor are the engines of world economy, more and more raw material like crude oil, iron ore, grain and coal would be carried from some natural resource countries (like OPEC countries, Australia, Brazil and Russia) to the manufacturing countries (like as Japan, China, South Korea and Germany). Meanwhile more and more products would be carried from these manufacturing countries to other consumer countries. Most demand of goods transportation is executed by maritime transport. Therefore, the maritime transport is a kind of global business that undertakes a long term and huge demand.

⑵ The development of maritime technology supports the growth of world economy strongly

In the past 200 years, great progress has been made in maritime technology. In material of hull, steel instead of wood so that vessel can be built bigger and bigger. In power of ship, diesel engines instead of nature powers like human, animal and wind so that the navigation could reduce its dependence on weather. In type of ship, more and more new types of vessel like tankers, bulk carriers, container vessels, LNG carriers, chemical vessels and ro-ro ships instead of old unitary type like sailing ships. Meanwhile the application of modern technology like GPS, maritime satellite and sonar enhance the safety of navigation greatly.

⑶ The progress of maritime business model promotes the diversity of international trade

Since the term ‘ship-owner’ first appeared in the shipping history in 1786, maritime business model has become vast. Tramp, liner, MTO, NVOCC and 3PL, each model supports different type of trade. Tramp is to be used in liquid and dry bulk goods (crude oil, iron ore, grain and coal) trade. Liner is to be used in products (machine, textiles, furniture, food and tool) trade. Usually both of tramp and liner just provides port to port service for shipper. MTO, NVOCC and 3PL are developed based on liner business. MTOs extend their services from sea ports to inland points like CFS or railway station. NVOCC is a kind of contract carrier who provides service to organize several actual carriers as a transport chain to move the goods from the place of receipt to the place of delivery. MTO and NVOCC are public carriers. They organize the special cargo transportation solutions and provide these services to public. 3PL supplies a kind of private goods management service that just provide to the core enterprise in the certain supply chain. The goods management service includes inventory control, transport, storage and order management etc.

⑷ The recession of world economy is crowning calamity to the maritime transport industry

Cycles are not unique to maritime transport market; they occur in many industries. All of oil market, ore market, grain market and finance market appear cycle’s wave. Because of the close relationship between commodity market and maritime transport market, cycles pervade the maritime transport industry. The cycles of maritime transport market is combined by three parts: long cycle, short business cycle and seasonal cycle (see Fig.1-2).

The main reason of long cycles is the global macroeconomic development cycle. The unbalance of vessel supplies and transport demands causes the short business cycle. Seasonal cycle is caused by the life cycle of product. For example, wheat and cotton is in summer, rice and corn is in autumn, in winter more coal and oil are needed for keeping warm.

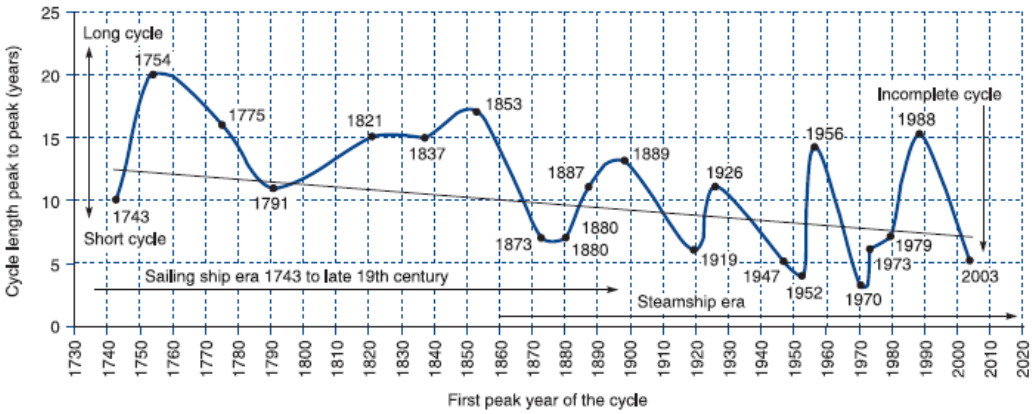


Fig.1-3 Cycles of maritime transport market, 1740–2007[10]

The recession of world economy is crowning calamity to the maritime transport industry. In 2008, the world economic recession resulted from subprime mortgage crisis in US. In global maritime transport market, same situation happened. On 20 May 2008, BDI as the barometer of shipping market reached 11,793 points, its record high level, since its introduction in 1985. Half a year later, on 5 December 2008, the index had dropped by 94%, to 663 points, the lowest since 1986. Hundred empty vessels anchored at open sea, thousand crews were unemployed at home. Many shipping companies went through the process of bankruptcy. Maritime industry faced more harsh reality than international trade industry.

⑸Summary

International trade drives the demand of maritime transport market. The scale of fleets in the world provides the capacity of maritime transport. In most cases of this market, the demand is in the leading position and is not affected by the internal factors of the market. The supply in a passive position, the main task is to meet the needs of international trade.

Although big data cannot influence world trade and maritime transport directly, various data products can provide more information to the market. Investors, managers, brokers, analysts can make decision that is more rational; reduce the market risk by using these data products. Only freight indices are not enough for the market today. This paper is searching the way to develop more indices by big data sets.

1.3 The function and shortage of maritime freight indices

According to the principle of economics, the market price reflects interaction between supply and demand. Each price corresponds to each kind of commodity or service in particular market. So that the maritime freight rate for specific goods is the result of interaction of international trade volume of these goods and capacity of global corresponding fleets in the market.

To show the commodity price lever compared with other region or other time, economists created a series of price indices by a normalized average (typically a weighted average) of price relatives for a given class of goods or services in a given region, during a given interval of time. Some notable price indices include the Consumer Price Index (CPI), the Producer Price Index (PPI) and the GDP deflator. This index method is applied in particular products or services: WTI

[10] Data source: Stopford M., 2009, Maritime Economics(3rd edition)

for oil, Platts for energy and metal, FPI for food, NASDAQ and NSA for stock, etc.

Being the most famous maritime freight index, the BDI is issued daily by the Baltic Exchange based in the City of London. Clarkson also issues a series of maritime freight indices and earning indices named ClarkSea Index daily. These indices give investors and brokers much help for their business development.

1.3.1 The function of the maritime freight indices

The functions of the maritime freight indices could be listed as follows:

⑴To help shipper and carrier to reach agreement on the freight rate

Freight rate is the indispensable clause in the bill of lading or the charter party. Shippers and carriers could make their forecasts for the new freight rate by freight index data in history. Then they can reach agreement of the freight rate easily. This is the basic function of the maritime freight indices.

⑵To help international trader forecast the cost of maritime transport

When buyer and seller of international trade negotiate their contract contents, maritime freight rate is an important part of commodity prices. Especially in the CIF and CFR conditions, seller needs to forecast the freight rate before chartering a vessel. In this situation, freight index could give him useful information for the cost of marine transport.

⑶To help investor estimate the revenue of maritime transport companies

Maritime transport is the high risk and sometime high revenue industry. According to the research of Martin Stopford, maritime freight rate used to be very low, sometimes suddenly rose to a very high level, and then dropped rapidly in a very short period. Therefore, in his book, the first sentence is “Shipping is a fascinating business”. No investor, no development of maritime transport. The confidence to the market and the future expected income are important means to attract investors. The maritime freight indices are the good tools.

⑷To provide a freight risk tool by the Forward Freight Agreement

Before 1985, maritime freight index was known only in shipping market. Appearance of BFI led maritime freight indices to global finance market. Now, the FFA based on the BDI is well known not only in maritime market, but also in global trade and finance market. The BDI is called even the barometer of global economy. Carrier, trader, charterer, broker, banker and investor could reduce their freight rate risk by handling the FFA.

1.3.2 The shortages of the present maritime freight indices

Although it is evident that the maritime freight indices have so many functions and are widely used, they still have a lot of shortcomings in the business practice now. These shortages can be listed as follows.

⑴The data source of the maritime freight indices is not comprehensive enough

At present, most of maritime freight indices are mainly based on the prices provided by brokers. The main bodies of the market like shippers and carriers seldom do this. Although the member of the Baltic Exchange is over 550, they still are the part of the global maritime transport market. Indexers put more attention to the tanker and bulk markets but a few on others (like ro-ro carrier market, chemical vessel market, new building market and demolition market). They have not set up efficient channels and systems to collect total maritime transport market data to create new indices for other markets.

The Shanghai Shipping Exchange created a series of indices for container liners market like as CCFI and SCFI. Its data sources also are very limited. The main channel is the freight filling system set by MOT of China. So the SSE only has the data of Chinese export container freight by support from government and just could issues export freight index weekly only for container liner market. It is just a kind of local freight index, but not global freight index.

There is no the indexer who can have all data of the global maritime transport market before the big data era.

⑵Existing products of the maritime freight indices just cover less than half of maritime market

Modern maritime transport market could be divided into four parts: tanker market for bulk liquids, bulk carrier market for dry bulk, container liner market for products and other markets for large equipment, offshore supplier and automobile etc. Although the transport volume of tanker market and dry bulk market some time is over half of total sea transport volume, but the value must be lower. Each index like BDI, BPI, BCI and BDTI just gives its price lever for one or several types of vessels.

There is still no any index product for total global maritime transport market now.

⑶Freight rate is not the only feature of maritime transport market

On the other hand, for maritime transport industry, freight rate is just one feature for the revenue of shipping company. Volume of transport also is the factor that could influence the revenue. Moreover, operating cost of shipping company also should be considered such as fuel price, salary of crew, port charge and ship depreciation.

For example, on Dec.5, 2008, WTI price of crude oil was 40.83USD/B, Brent price of crude oil was 37.18 USD/B, and BDI was 663 point. On Dec.28, 2012, WTI price of crude oil was 101.17USD/B, Brent price of crude oil was 110.32 USD/B, and BDI was 699 point. It was evidence that the bulk carriers were more difficult on Dec.28, 2012 although the BDI was higher than Dec.5, 2008.

There is no suitable index that could give a reasonable explanation for the phenomenon like the case above.

⑷Most of maritime freight indices is for business not for the real market

All of the indices existing in maritime transport market are for business. The reasons are: ① the indexers are businessmen or companies such as the Baltic Exchange and the Clarksons Research Service Ltd, even the Shanghai Shipping Exchange; ②the sponsors and users are businessmen or companies such as RBS, NYK, BHP and NSC etc.; ③ business mechanism provides the power to be continuously improved for the indices system.

Although the market “was led by an invisible hand”, market failure still occurred occasionally. The global maritime transport market is no exception. For example, BDI usually could give the freight rate lever of bulk market. But the Baltic Exchange could not give the time and drop range for the rapid decline in 2008. Fig.1-4 shows the BDI and the BDTI curves from Jan. 2000 to Dec. 2015. After the incidents, the risks and opportunities can be found easily. Most of investors wish to know what will happen tomorrow in the global maritime market. The maritime freight indices could not give a reasonable answer.

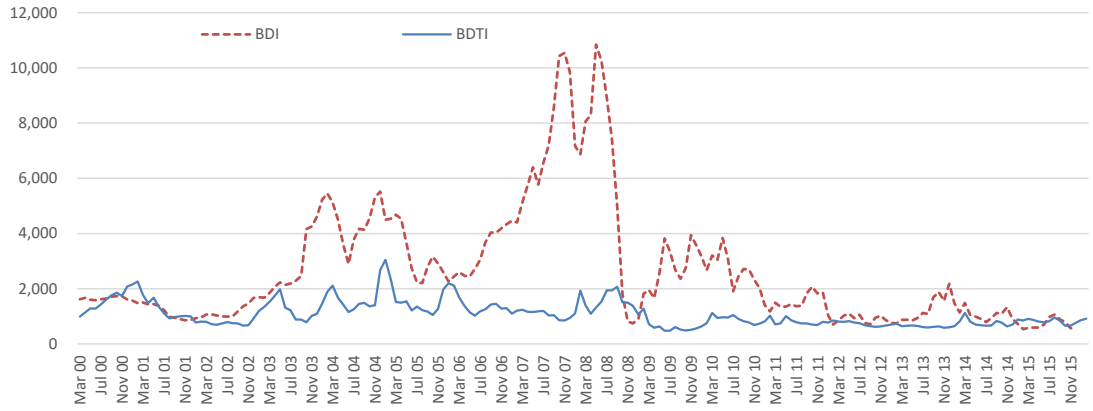


Fig.1-4 The BDI and the BDTI (Jan.2000 to Dec. 2015)[11]

1.4 Purpose and methodology

1.4.1 Purpose

Based on the big data and the index theory, the purpose of this research is to set up the indices products framework of global maritime transport market, to find the possibilities of the prosperity index which can show the future tendency, reflect the panorama of the global maritime freight market, and give an early warning before crisis for investors. This kind of index can be called the prosperity index of global maritime transport (PIGMT).

Meanwhile, the third party logistics service (3PLS) take more and more important role in global economy development like in China. Most of global 3PLS include container line or/and airline service. But there is no suitable global freight index for them to estimate the cost of transportation. Based on big data tendency of e-booking platform, this paper will test the possibilities of the daily container freight index (DCFI). With same method, the daily airline freight index also will be calculated. Furtherly, the global cargo freight index will be created.

When more and more freight indices are developed, the PIGMT will have more data sources and the result will be more close to real market.

1.4.2 Methodology

There are many index products of maritime transport issued by different organizations in various ways such as on newspapers, on magazines and on webpages, even on mobile phone. These indices have different data sources, calculation methods, clients and expression forms. According to the principle of big data, the first step of this research is to collect the maritime indices as more as possible. The second step is to classify these index products from different angles. The third step is to find the position and functions of every product in the global maritime transport market.

These existing index products are developed for the maritime transport market. To ensure the defects of these index products, the framework of global maritime transport market should be described in detail first. In Chapter 3, the modern structure of global maritime transport market

[11] Data source: https://sin.clarksons.net/Index

was showed. Meanwhile the economy characteristics of the whole market and sub markets also need to be revealed.

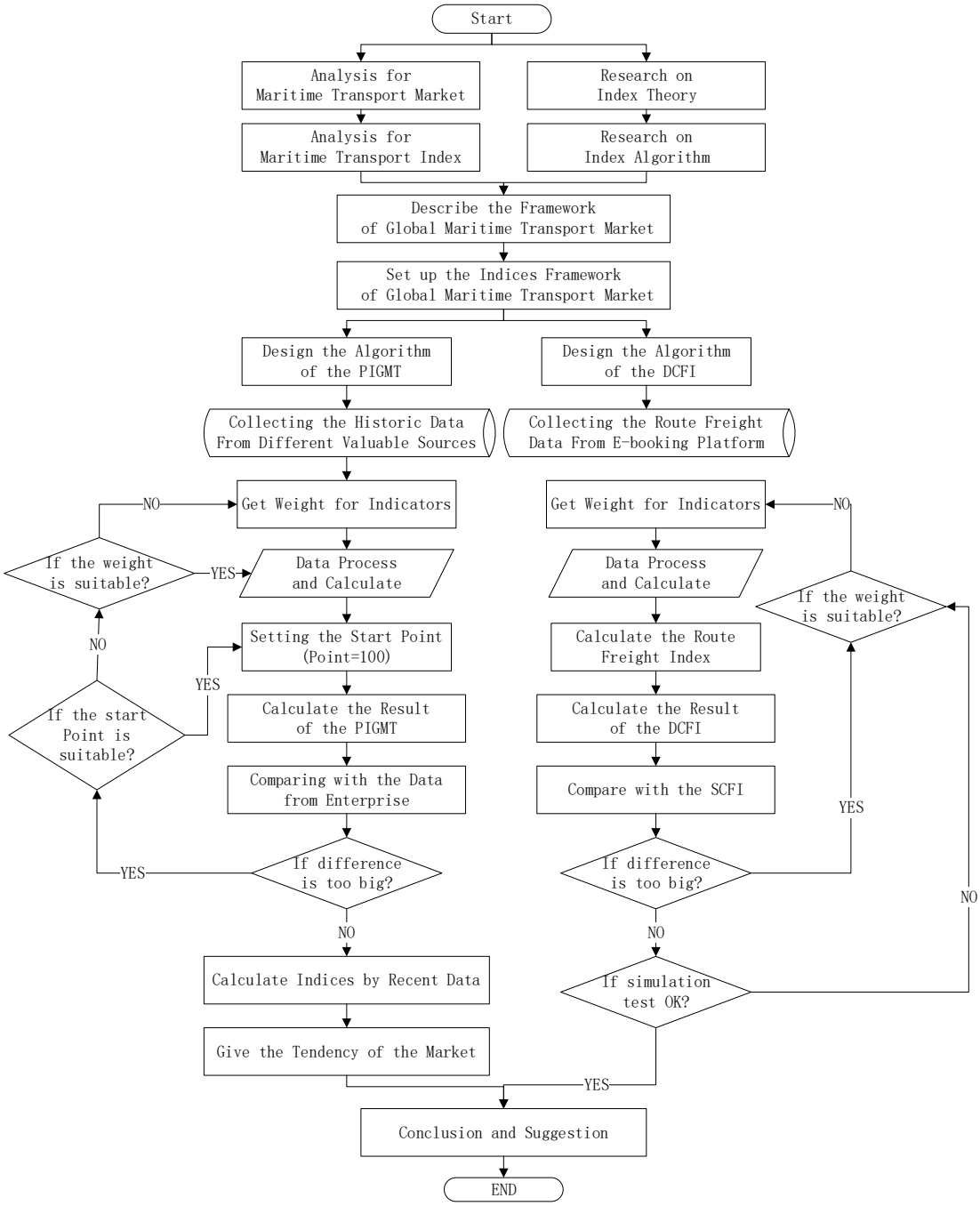


Fig. 1-5 The process of the research

Economists created a lot of indicators and their various calculation methods. Based on the demand to new indices in the global maritime transport market, it is necessary to search the suitable indicator arithmetic, especially in business cycles indices because the global maritime transport market is also a kind of business market. In Chapter 4, there were a lot of material for the application cases of prosperity indices and price indices.

Combined the feature of market and calculation method of suitable indices, the new indices

model could be created for the global maritime transport market. In Chapter 5, the PIGMT was given by using the composite index methodology.

Fig.1-5 gives the process of this research.

Furtherly, in the indicators system of the global maritime transport prosperity index, some are not suitable but still used as no better indicator like container freight index. We think the big data strategies of many countries provide the possibility to develop the global container freight index based on various e-booking platforms. In Chapter 6, the DCFI was created. By implementing the index to a risk analysis problem, numerical results can be used to show the DCFI's potential position in real investments for container liner markets.

1.5 Main opinions and creations

1.5.1Main opinions

⑴The global maritime transport market is borderless. So every investment in this market is borderless. Investors just concern the global index but not local index. Local freight index is only useful for shippers and carriers in local market.

⑵For investor, the profit of company is more important than revenue. So the prosperity index can give the situation more correctly than freight index for investor as the freight rate just indicate the revenue of shipping company but not cost.

⑶The business cycle theory can be used in global maritime transport market as it is also a cycle market.

⑷The PIGMT can be created by composite index method with both of static and dynamic weight.

⑸With the action of the big data strategy plan, more and more freight indices can be created such as the DCFI. In big data era, the PIGMT will be more accurate.

1.5.2Main creations

⑴Proved that only freight index is not enough for investors, prosperity index is needed in global maritime transport market.

⑵Designed the framework of data products of the global maritime transport market.

⑶Designed the algorithm of the PIGMT according to the methodology of business cycle index, and tested its correction. The result is reliable.

⑷Designed the algorithm of the DCFI based on e-booking platform.

Chapter 2 Character Analysis of Maritime Transport Market

Based on principle of big data, it is necessary to outline the overall indices framework of the global maritime transport market first. For this purpose, this chapter tries to show the essence of the maritime transport industry. Then every indicator for character of the market can be found. Also, this chapter will introduce the nature of the market and refine the key research result on the indices of global maritime transport market.

2.1 Introduction of global maritime transport market

2.1.1General situation of modern global maritime transport

⑴The growth of global merchandise trade, the cornerstone of maritime transport

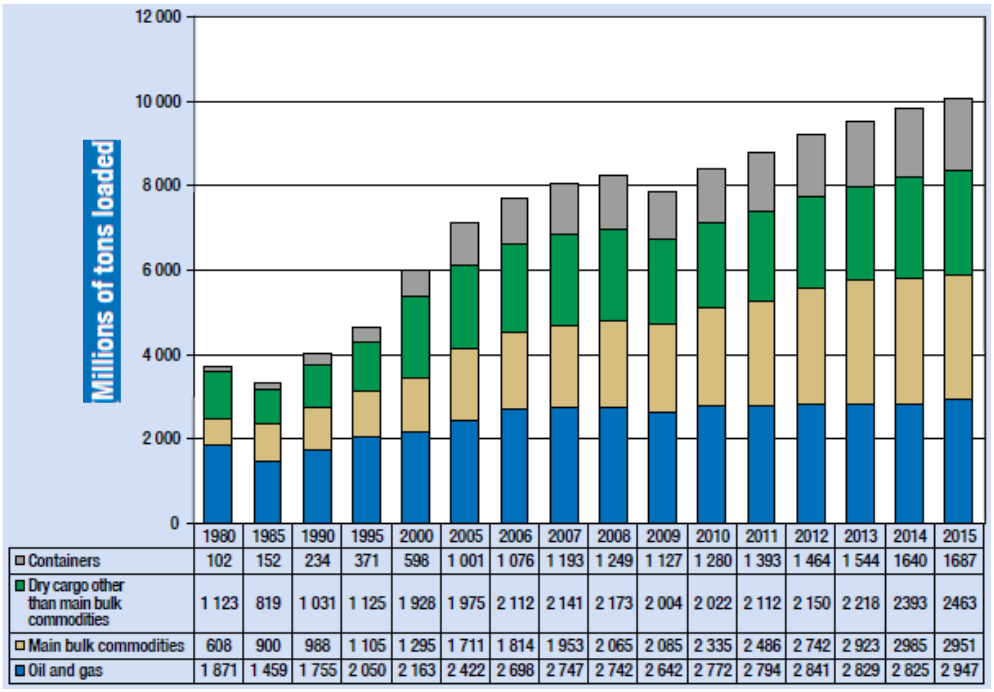
Maritime transportation is the backbone of international merchandise trade and a key engine diving globalization. Around 80% of global trade by volume and over 70% by value is carried by sea and is handled by ports world; these shares are even higher in the case of most developing countries.

Meanwhile, global maritime transport is based on service for global merchandise trade. As the influence of the financial crisis in 2008 USA, global economic recession, but the global merchandise trade still grew. According to the report of WTO, measured in gross terms, the dollar value of world merchandise trade increased by more than 7 per cent per year on average between 1980 and 2011, reaching a peak of US$ 18 trillion at the end of that period. Trade in commercial services grew even faster, at roughly 8 per cent per year on average, amounting to some US$ 4 trillion in 2011. Real merchandise trade growth (i.e. trade growth accounting for changes in prices and exchange rates) was equally impressive, recording a four-fold increase in volume between 1980 and 2011. Since 1980, world trade has grown on average nearly twice as fast as world production. Reductions in tariffs and other barriers to trade during this period contributed to the expansion. The modest 2.5 per cent rise in world merchandise trade volume in 2014 was again roughly equal to the 2.5 per cent increase in world GDP for the year. It also marked the third consecutive year in which world trade volume grew less than 3 percent. Trade growth averaged just 2.4 per cent between 2012 and 2014, the slowest rate on record for a three-year period when trade was expanding (excluding years like 1975 and 2009 when world trade actually declined).

UNCTAD estimates global trade to have increased by 3.4% with the total reaching over 9.84 billion tons in 2014 for first time ever. Driven in particular by growing domestic demand in China and intra-Asian and South-Asian trade, seaborne trade nevertheless remains subject to persistent downside risks facing the world economy and trade. Freight rates have remained low and volatile in the various market segments (container, liquid and dry bulk). Fig.2-1 gives maritime transport volume for four kinds of cargo from 1980 to 2014.

⑵Framework of global maritime transport market

Global maritime transport market is very complex. It can be divided into six parts: maritime transport market, shipping service market, ship market, maritime information market, shipping capital market and shipping risk market.



	1980	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Containers	102	152	234	371	598	1 001	1 076	1 193	1 249	1 127	1 280	1 393	1 464	1 544	1640	1687
Dry cargo other than main bulk commodities	1 123	819	1 031	1 125	1 928	1 975	2 112	2 141	2 173	2 004	2 022	2 112	2 150	2 218	2393	2463
Main bulk commodities	608	900	988	1 105	1 295	1 711	1 814	1 953	2 065	2 085	2 335	2 486	2 742	2 923	2985	2951
Oil and gas	1 871	1 459	1 755	2 050	2 163	2 422	2 698	2 747	2 742	2 642	2 772	2 794	2 841	2 829	2 825	2 947

Fig.2-1 Maritime transport volume of four kinds of cargo[12]

International merchandize trade is the base of whole market. As the rapid development of shipbuilding technology, maritime transport supply capacity is over the demand for long time. Tramp and liner are two kinds of core service in maritime transport. Port company, class society, human resource service and ship supply, etc. are shipping service vendors. Ship market is the adjustment of transport capacity in the market. Tramp, liner, shipping service and ship markets are the fundamental parts for transport operation. Fig. 2-2 shows the structure of global maritime transport market.

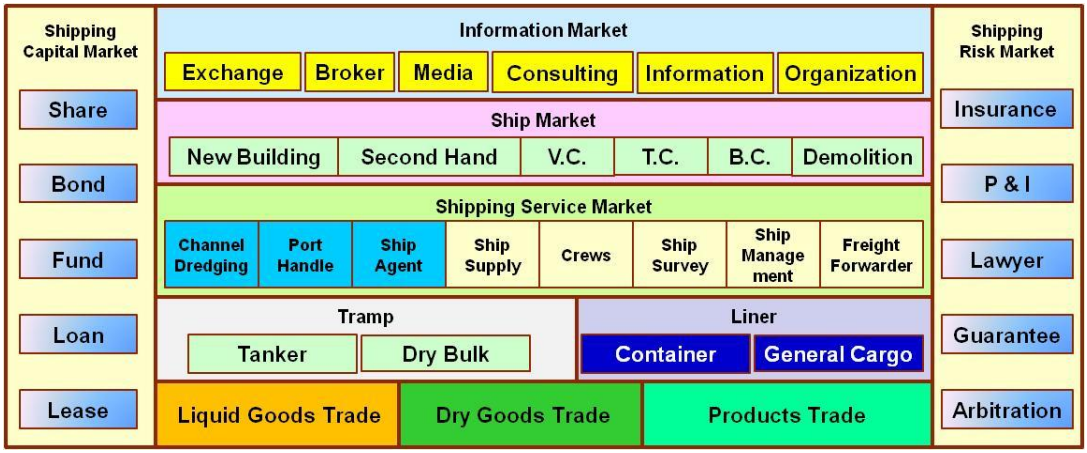


Fig.2-2 General structure of global maritime market

①Maritime transport market

Maritime transport market includes two parts: shippers and carrier. Each of seller and buyer

[12] Data source: UNCTAD. 2016, Maritime Transport Review 2016

in sales contract can be shipper. Merchants who buy or sell oil, iron ore, grain, coal and finish goods are shippers. Owner of ship, charterers, NVOCC, MTO and liner are carriers. In this market, shippers purchase the transport service and pay freight to carriers; carriers supply goods displacement service to shippers and take freight as their revenue.

There are two types of business model in maritime transport market: tramp and liner. Tramp is generally suitable for bulk cargo, including dry bulk and liquid bulk cargo. Iron ore, grain, coal and bauxite are dry bulk. Crude oil, products oil, liquid chemical products and liquid gas are liquid bulk. Voyage charter and time charter are two typical business types of tramp.

②Shipping service market

To make maritime transport smooth, many services should supply to carriers and shippers. The function of channel dredging is to maintain channel safety for navigation. Port companies supply the services like as ship berth, cargo handling and distribution, etc.. Ship agency makes affair at appointed port on behalf of shipowner. Ship supply company provides the ships as agent of shipowners. Crew company provides human resource management of crew for carrier. Ship survey used to be executed by the class society like Lloyds Register, Nippon Kaiji Kyokai, American Bureau of Shipping, Bureau Veritas, etc. Freight forwarder is a bridge link between shippers and liners who collect and distribute the goods. Ship management company provides asset management service on vessel as object for shipowners.

Following the trends of globalization, the business of ship supply, crews service, ship survey ship, management and freight forwarder become more and more internationalized.

③Ship market

Ship market is a supply chain based on ship from new building to demolition. In this market, most of seller and buyer are shipowners, some are NVOCC or MTO. Broker companies are the bridges that link between each and every clients.

Shipyards build new vessels to shipowners. Shipowners exchange the vessels each other according to the cargo situation by brokers. Shipowners can sell their vessels to reduce the scale of fleet, or charter the vessels. In the life cycle, a vessel can be sold as second hand vessel to another carrier, or be rented out under charter party, like voyage charter, time charter and bareboat charter. If the international merchandize trade is in recession, some old or lower efficient ships will be put in demolition.

④Maritime information market

This is a never ending market even though maritime transport market is silent. As the affiliate of United Nations, IMO is an intergovernmental organization which locates in London and focuses on maritime technology and navigation safety. There are many non-government organizations such as BIMCO, IACS in this market. Lloyds List and Seatrade are the typical representatives of the media. The history of Lloyds is over 330 years. The most famous exchange is Baltic Exchange in maritime transport market. Clarkson, SSY and HR are very strong broker companies. Drewry and Tradewind are very professional consulting companies in this market. With internet technology, some information companies pay more attention to this market. They develop a lot of professional software to various shipping companies. With the arrival of the era of big data, information company has become more and more important in the maritime transport market.

⑤Finance market

The maritime transport is a high capital demand market. One massive vessel may value over one billion US dollars. Ten million US dollars vessels can be found everywhere. As the maritime transport industry is a supply chain, infrastructure investment happen not only in vessel even in fleet but also in port and cannel. It is huge demand for capital. There are enormous challenges and super opportunities. If considering the cash flow on the trade mercantile, capital demand will be more of surprise. For example, the value of a 18000TEUs container vessel with full load consists of two parts: vessel and box' s value (about 200 million US dollars) and cargo value (about 450 million US dollars).

Finance market supplies huge money to maritime transport market by different channel: bank loan, stock market, bond sale, all kinds of funds, etc.. HSBC and RBS set their shipping finance department to support this kind of business. Some investor organize a lot of funding like KG in the market. More shipping companies raise funds through the issuance of shares. Ship finance in leasing has become a popular business. But, in KPMG's opinion, Basel III and stricter bank regulation affect shipping financing; traditional capital sources are no longer so abundant.

⑥Risk Market

High opportunity, high risk. Each person in maritime transport market manage his risk, so that risk management has become a kind of business. Insurance, reinsurance and P&I are typical risk business. Located in London, Lloyd's as the world's specialist insurance market is the leader in global marine insurance. Some judicial process can be used to avoid risks like hiring lawyer, arbitration, etc.. Financial institutions to provide each other with guarantee or credit insurance is also a kind of risk management of business.

⑶Tramp and liner are two basic forms of maritime transport

With the continuous development of professionalization of vessels, global maritime market is constantly differentiation. Table 2-1 gives various kinds of special types of vessels. Combining table 2-1 and table 3-4, the complexity of the maritime transport system can be understood easily.

Tab.2-1 Ship type

Type Group	Constituent Ship Type
Oil Tanker	Crude oil tanker, Product oil tanker, Liquid product tanker
Bulk carrier	Coal carrier, Iron-ore carrier, grain carrier,
General-cargo ship	Multi-purpose and project vessel, Roll-on roll-off carrier, General cargo vessel
Container vessel	Full container vessel, Ro-ro container carrier, Float on/off container ship
Passenger carrier	Cruise, Ferrier, Passenger-cargo vessel,
Other ships	Reefers, Offshore supply, Tug, Forest products carrier, Semi-submersible ships, Barge, Dredgers, Cable laying vessel, Floating crane, Ice breaker

Martin Stopford summarized the maritime transport economic model in Fig. 2-3.

Starting at the top of this diagram (row A), world trade splits into three streams – bulk parcels, specialized parcels and general cargo parcels – depending on the PSD function for the commodity and service requirements of each cargo parcel. Large homogeneous parcels such as iron ore, coal and grain are carried by the bulk shipping industry; small parcels of general cargo are carried by

the liner shipping industry; and specialized cargoes shipped in large volumes are transported by the specialized shipping industry. These three cargo streams create demand for bulk transport, specialized transport and liner transport (row B). The lower half of the diagram shows how the supply of ships is organized. A major distinction is drawn between the fleets of ships owned by the companies moving their own cargo in their own ships (row C) and the ships owned by independent ship-owners (row D) and chartered to the cargo owners in Row C. Between rows C and D are the charter markets where rates for transport are negotiated. This is a highly flexible structure. For example, an oil company might decide to buy its own fleet of tankers to cover half of its oil transport needs and meet the other half by chartering tankers from ship-owners. The same applies to the specialized and liner markets.

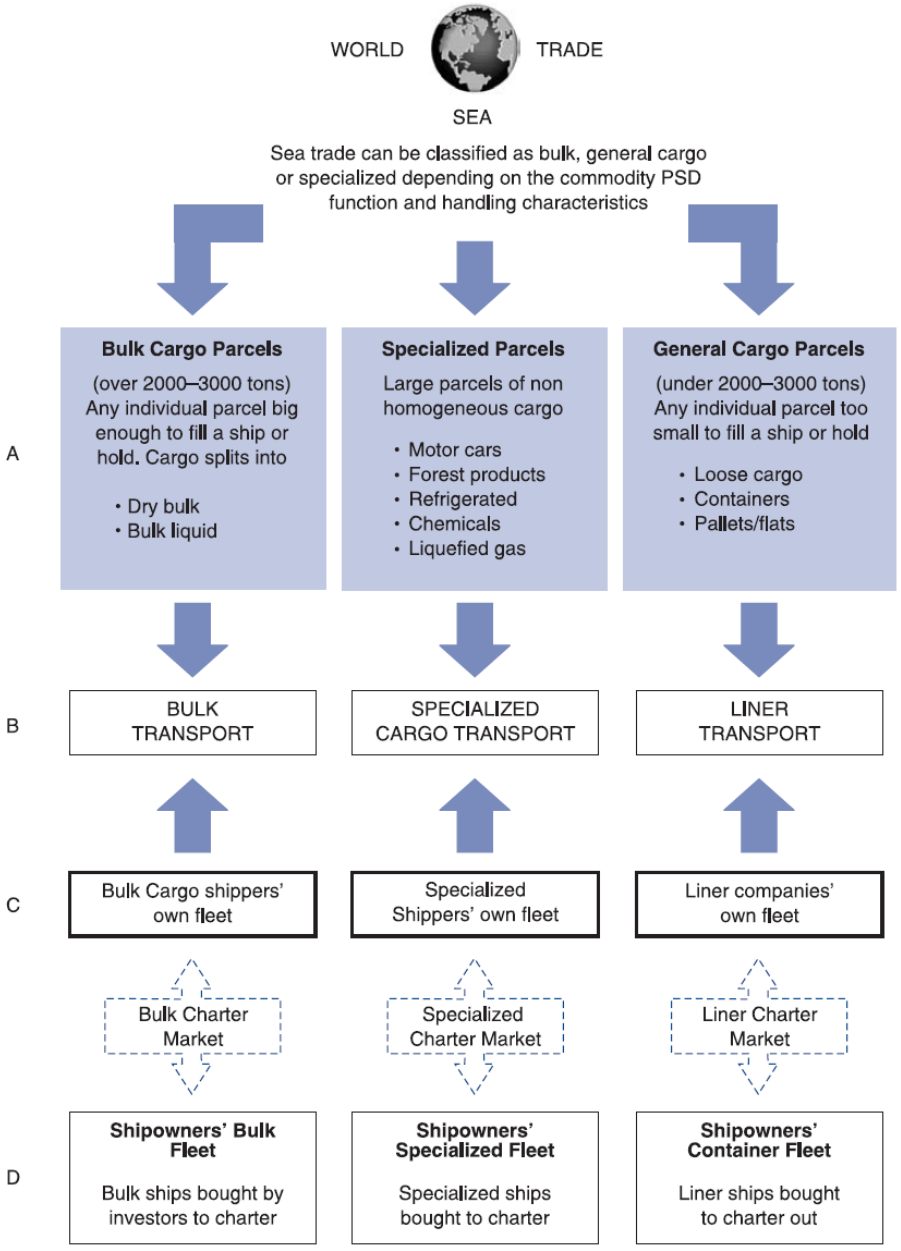


Fig.2-3 The supply and demand relationship of maritime transport market[13]

[13] Data source: Stopford M., 2009, Maritime Economics(3rd edition)

The bulk shipping industry on the left of Fig. 2-3 carries large parcels of raw materials and bulky semi-manufactures. This is a very distinctive business. Bulk vessels handle few transactions, typically completing about six voyages with a single cargo each year, so the annual revenue depends on half a dozen negotiations per ship each year. In addition, service levels are usually low so little overhead is required to run the ships and organize the cargo. Typically bulk shipping companies have 0.5–1.5 employees in the office for every ship at sea, so a fleet of 50 ships worth $1 billion could be run by a staff of 25–75 employees, depending on how much of the routine management is subcontracted. In short, bulk shipping businesses focus on minimizing the cost of providing safe transport and managing investment in the expensive ships needed to supply bulk transport.

The liner service, shown on the right of Fig. 2-3, transports small parcels of general cargo, which includes manufactured and semi-manufactured goods and many small quantities of bulk commodities – malting barley, steel products, non-ferrous metal ores and even waste paper may be transported by liner. For example, a container-ship handles 10,000–50,000 revenue transactions each year, so a fleet of six ships completes 60,000–300,000 transactions per annum. Because there are so many parcels to handle on each voyage, this is a very organization-intensive business. In addition, the transport leg often forms part of an integrated production operation, so speed, reliability and high service levels are important. However, cost is also crucial because the whole business philosophy of international manufacturing depends on cheap transport. With so many transactions, the business relies on published prices, though nowadays prices are generally negotiated with major customers as part of service agreement. In addition, cargo liners are involved in the through-transport of containers. This is a business where transaction costs are very high and the customers are just as interested in service levels as price.

Specialized shipping services, shown in the middle of Fig. 2-3, transport difficult cargoes of which the five most important are motor cars, forest products, refrigerated cargo, chemicals and liquefied gas. These trades fall somewhere between bulk and liner–for example, a sophisticated chemical tanker carries 400–600 parcels a year, often under contracts of affreightment (COAs), but they may take ‘spot’ (i.e. individually negotiated) cargoes as well. Service providers in these trades invest in specialized ships and offer higher service levels than bulk shipping companies. Some of the operators become involved in terminals to improve the integration of the cargo-handling operations. They also work with shippers to rationalize and streamline the distribution chain. For example, motor manufacturers and chemical companies place high priority on this and in this sector the pressure for change often comes from its sophisticated clients.

So although the three segments of the shipping industry shown in Fig. 2-3 all carry cargo in ships, they face different tasks in terms of the value and volume of cargo, the number of transactions handled, and the commercial systems employed. Bulk shipping carries the high-volume, price-sensitive cargoes; specialized shipping carries those higher-value ‘bulk’ cargoes such as cars, refrigerated cargo, forest products and chemicals; the container business transports small parcels; and air freight does the rush jobs. But these segments also overlap, leading to intense competition for the minor bulk cargoes such as forest products, scrap, refrigerated cargo and even grain.

2.1.2 Supply chain in maritime transport

⑴ Supply chain in tramp market

Tramp market is a traditional market. The business model of tramp has been set up since 17th Century. Fig.2-4 gives the explanation for the business model. The buyer at A port signs a purchase contract with the seller at B port with FOB rule.

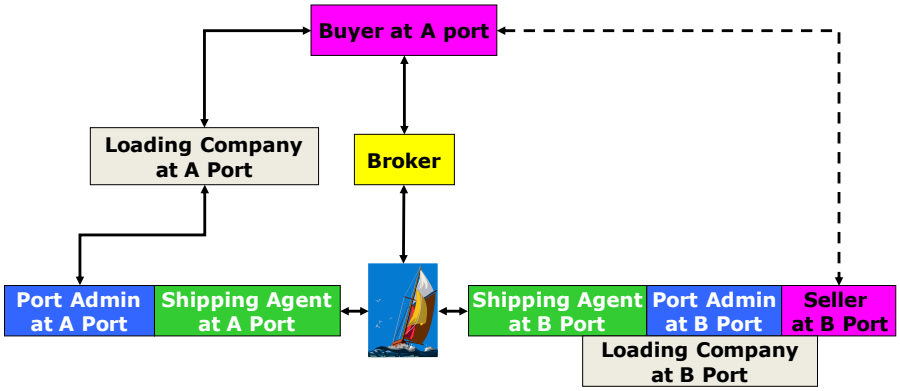


Fig.2-4 The business model in tramp market

Then the buyer invites a broker to find a suitable carrier to take the goods back. The carrier arranges the vessel and shipping agencies in B port of loading and A port of discharge after voyage charter party is signed. After the activities above is done, the navigation from A port to B port starts. When the goods are unloaded safely from the vessel at A port, the maritime transport service for the purchase contract is finished.

Being the conversion of Fig. 2-3, Fig.2-4 gives the supply chain in tramp market. In this chain, central line is from shipyard to ship owner, carrier and cargo owner. Cargo owner can be the core when the market is a buyer's market; ship owner can be the core when the market is a seller's market.

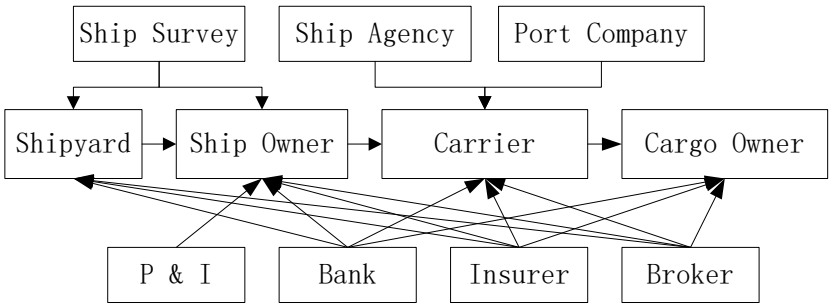


Fig.2-5 Supply chain in tramp market

In Fig.2-5, it is easy to be found that bank, insurer and broker can provide their service to everyone in central line directly. On the other side, ship owner or cargo owner is the buyer in the shipping finance market. When the maritime transport market faces money shortage, investors should make their decision with the market prosperity situation.

⑵Supply chain in liner market

In the late of 19th Century, some carriers found that the trade volume between A, B, C and D

ports was stable and with good growth potential. They arranged certain vessels navigated between these ports with fixed schedule. In this situation, carrier needed to sell the freight space to cargo owner. Freight forwarders appeared. They wholesaled the hull space from liners and retailed them to cargo owners (dealer of sales contract).

Fig.2-6 gives the business model in liner market.

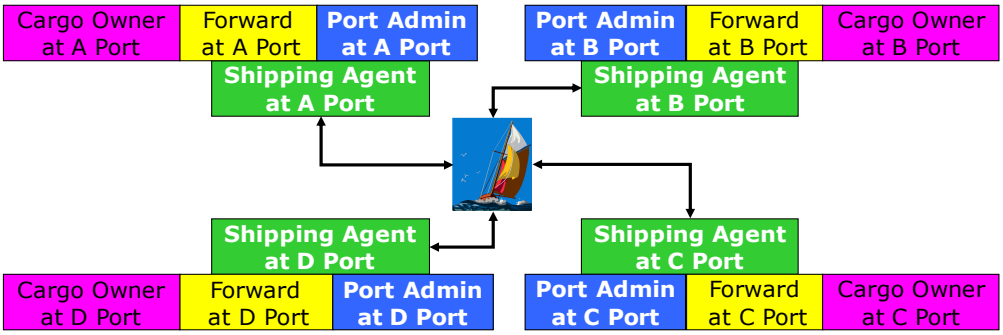


Fig.2-6 The business model in liner market

Being the conversion of Fig.2-6, Fig.2-7 gives the supply chain in liner market. In this chain, central line is from port operators to liners and manufacturers. As the number of manufactures is much bigger than the number of liners, the liners have more power in the chain. Some port operators enhance their competition by setting up global port alliance or purchasing the share of these ports. Hutchison, PSA and DP World are good examples.

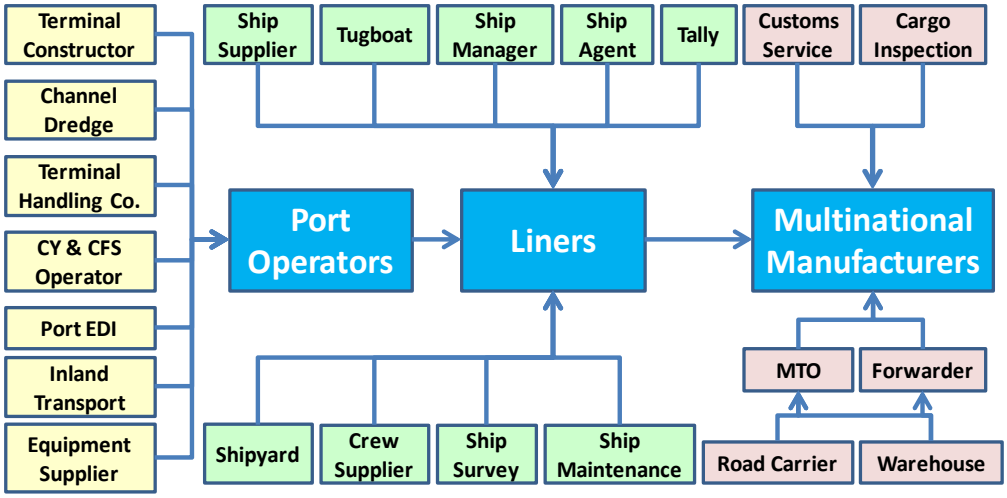


Fig.2-7 Supply chain in liner market

Although there is no financial part in Fig.2-7, it is necessary for liner market to have finance and insurance support. This support demand is huge and overall market, not just for one or several parts of it. The further problem is that for investors, tramp market or liner market, which has better investment potential?

2.2 The economic characteristics of global maritime transport

Global maritime transport market is borderless. The case is: A shipping company registered

in M country, takes goods whose seller is B, a trader registered in E country, buyer is C, a trader registered in F country, from S port in N country to T port in Q country with the vessel registered in U country, receives the freight fee in R country's currency by the D bank in V country. The problem is: which country this business belongs to? The answer must be: it is a global business.

2.2.1 General economic characteristics of global maritime transport

International shipping transports about 90 per cent of global trade to people and communities all over the world. Shipping is the most efficient and cost-effective method of international transportation of goods, providing a dependable, low-cost means of transporting goods globally, facilitating commerce and helping to create prosperity among nations and peoples. Global food security is dependent on a safe and secure delivery method-international shipping. Shipping also delivers energy for all and is a life-line for trade and for manufacturing industries.

Tab.2-2 Top 35 countries (or territories) with large owned fleets as of 1 January 2015 (dwt) [14]

Rank (dwt)	Number of vessels				Dead-weight tonnage				
	Country/Territory of ownership	National flag	Foreign flag	Total	National flag	Foreign flag	Total	Foreign flag as a% of total	Total as a % of world
1	Greece	796	3221	4017	70425265	209004526	279429791	74.80%	16.11%
2	Japan	769	3217	3986	19497605	211177574	230675179	91.55%	13.30%
3	China	2970	1996	4966	73810769	83746411	157557180	53.15%	9.08%
4	Germany	283	3249	3532	12543258	109492374	122035632	89.72%	7.04%
5	Singapore	1336	1020	2356	48963688	35038564	84002252	41.71%	4.84%
6	Republic of Korea	775	843	1618	16032807	64148678	80181485	80.00%	4.62%
7	Hong Kong, China	727	531	1258	56122972	19198299	75321271	25.49%	4.34%
8	United States	789	1183	1972	8731781	51531743	60263524	85.51%	3.47%
9	United Kindom	477	750	1227	12477513	35904386	48381899	74.21%	2.79%
10	Morway	848	1009	1857	17066669	29303873	46370542	63.20%	2.67%
11	Taiwan,China	117	752	869	4681240	40833077	45514317	89.71%	2.62%
12	Bermuda	5	317	322	289818	41932611	42222429	99.31%	2.43%
13	Denmark	392	538	930	15286153	20893511	36179664	57.75%	2.09%
14	Turkey	576	954	1530	8321506	19366264	27687770	69.95%	1.60%
15	Monaco		260	260		23929323	23929323	100.00%	1.38%
16	Italy	596	207	803	15961983	6040199	22002182	27.45%	1.27%
17	India	697	147	844	14546706	7268449	21815155	33.32%	1.26%
18	Brazil	228	163	391	3150493	17308798	20459291	84.60%	1.18%
19	Belgium	87	156	243	1302545	12787196	20089741	63.65%	1.16%
20	Russia Federation	1291	448	1739	5920435	12403644	18324079	67.69%	1.06%
21	Islamic Repiblic of Iran	157	70	227	3986804	14093340	18080144	77.95%	1.04%
22	Switzerland	47	291	338	1403668	16492768	17896436	92.16%	1.03%
23	Indonesia	1504	153	1657	12908577	4120935	17029512	24.20%	0.98%
24	Netherlands	775	445	1220	6589901	10415708	17005609	61.25%	0.98%
25	Malasia	466	142	608	8430359	7707526	16137885	47.76%	0.93%
26	United Arab Emirates	95	684	779	472967	14845550	15318517	96.91%	0.88%
27	Saodi Arabia	86	155	241	2004631	11358349	13362980	85.00%	0.77%
28	France	180	277	457	3517344	7636312	11153656	68.46%	0.64%
29	Cyprus	141	179	320	3811947	6858661	10670608	64.28%	0.62%
30	Viet Nam	786	92	878	6527639	1510645	8038284	18.79%	0.46%
31	Kuwait	42	27	69	5293213	2462656	7755869	31.75%	0.45%
32	Canada	209	139	348	2743006	5004054	7747060	64.59%	0.45%
33	Oman	6	31	37	5842	7008489	7014331	99.92%	0.40%
34	Sweden	101	234	335	1248460	5194955	6443415	80.62%	0.37%
35	Quatar	56	70	126	888093	5471554	6359647	86.04%	0.37%

Maritime transport is composed of the maritime shipping and the ports dimensions, which are the most globalized industry, having assets present in every market. The global market is dominated by a few maritime shipping companies in close relationship with global terminal operators, some of which are parent companies. The system is oligopolistic (10 dominant shipping

[14] Data source: UNCTAD. 2015, Maritime Transport Review 2015

companies and 4 global terminal operators), but highly competitive. A powerful economic force in maritime shipping in the last two decades has been economies of scale leading to larger container ships, placing pressures on port terminal and inland freight distribution to cope. The complexities of global freight distribution and shipping networks have favored the emergence of intermediate hubs connecting different systems of circulation.

The National Ocean Economics Program (NOEP) made definitions for ocean economy and coastal economy in 2009: the coastal economy is total amount of economic activity originating in coastal regions; the ocean economy is employment, wages and output from 6 sectors (construction, living resource, minerals, ship and boat building, tourism and recreation, marine transportation) and 21 industries. There are 5 industries (deep maritime freight transport, marine passenger transport, marine transport services, search and navigation equipment, warehousing) in marine transport sector. NOEP thinks marine transport industry is a part of national economy.

UNCTAD presented the national concentration of fleet ownership is illustrated by the fact that owners from five countries – in order of decreasing tonnage, Greece, Japan, China, Germany and the Republic of Korea – together account for 53 percent of world tonnage. Among the top 35 ship-owning economies, 17 are in Asia, 14 in Europe, and 4 in America (table 2-2).

Tab.2-3 Leading exporters and importers in world merchandise trade[15]

Rank	Exporter	Value	Share	Annual Percentage Change	Rank	Importer	Value	Share	Annual Percentage Change
1	China	2049	11.1	8	1	United States	2336	12.6	3
2	United States	1546	8.4	4	2	China	1818	9.8	4
3	Germany	1407	7.6	-5	3	Germany	1167	6.3	-7
4	Japan	799	4.3	-3	4	Japan	886	4.8	4
5	Netherlands	656	3.6	-2	5	United Kindom	690	3.7	2
6	France	569	3.1	-5	6	France	674	3.6	-6
7	South Korea	548	3.0	-1	7	Netherlands	591	3.2	-1
8	Russian	529	2.9	1	8	Hong Kong, China	553	3.0	8
9	Italy	501	2.7	-4	9	South Korea	520	2.8	-1
10	Hong Kong, China	493	2.7	8	10	India	490	2.6	5
11	United Kingdom	474	2.6	-6	11	Italy	487	2.6	-13
12	Canada	455	2.5	1	12	Canada	475	2.6	2
13	Belgium	447	2.4	-6	13	Belgium	437	2.4	-6
14	Singapore	408	2.2	0	14	Mexico	380	2.0	5
15	Saudi Arabia, Kingdom of	388	2.1	6	15	Singapore	380	2.0	4
16	Mexico	371	2.0	6	16	Russian	335	1.8	4
17	United Arab Emirates	350	1.9	16	17	Spain	335	1.8	-11
18	Chinese Taipei	301	1.6	-2	18	Chinese Taipei	270	1.5	-4
19	India	294	1.6	-3	19	Australi	261	1.4	7
20	Spain	294	1.6	-4	20	Thailand	248	1.3	8

Comparing table 2-2 and 2-3, it is obvious that Greece is the biggest ship owning country, but out of 50 exporters ranking and 47 importers ranking. United States owns 3.61% share of global deadweights, with 8.4% export share and 12.6% import share. If only U.S. flag ships be considered, the share will be 0.537%. That means most of import and export goods of U.S. is transported by non U.S. flag vessels; Most of vessels with Greece flag transport non Greece import and export goods. This phenomenon fully proves that the maritime transport industry's globalization status.

[15] Data Source: www.wto.org/english/res_e/statis_e/its2013_e/its2013_e.pdf

For shipping companies in developed countries, higher salary and taxes reduce their profits. Global business characteristics push more and more vessels with foreign flags. This tendency is more obvious recently. As a reflection of most recent ships being larger than older ones, the global average pre ship shows an age of 20.3 years, while the average age by deadweight is 9.6 years. Their geographical distribution is also well balanced and ships registered in developing countries are now only slightly older (two years) than those flying the flag of developed countries. Among the 10 major flag states, Greece has the oldest fleet, followed by Panama and China. The youngest fleets are those registered in the Marshall Islands, Hong Kong (China) and Singapore. On average, foreign-flagged ships are slightly younger than nationally flagged ones. Fig.2-8 gives the age structure of world fleet, national and foreign flags. This phenomenon indicates that the globalization process of international maritime transport industry is deepening continually.

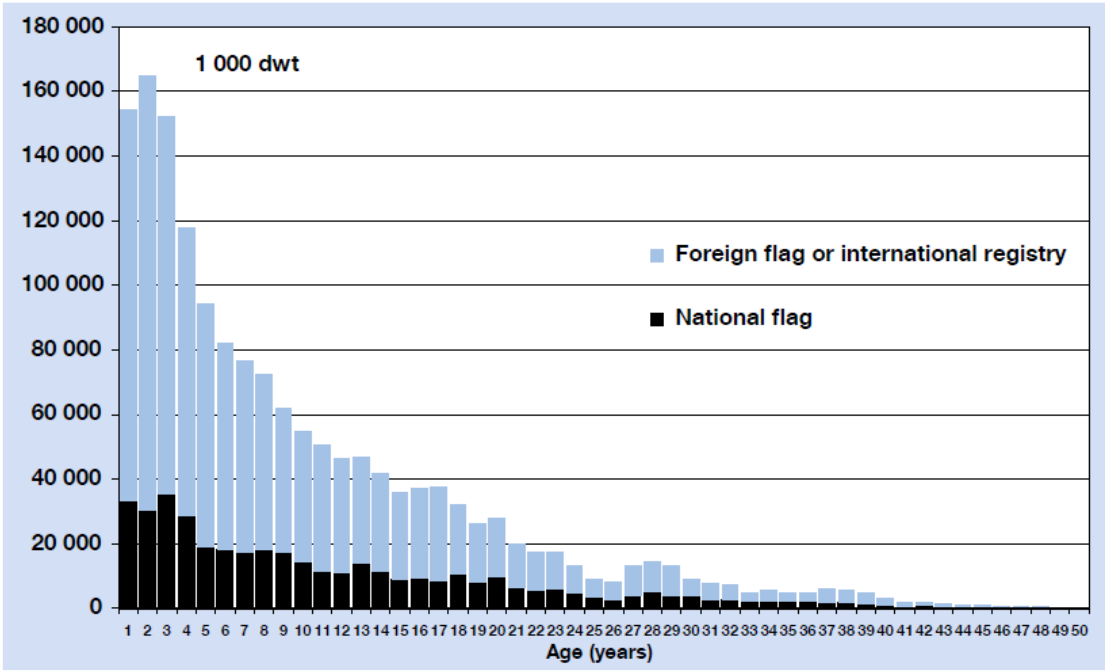


Fig.2-8 The age structure of world fleet, national and foreign flags[16]

Generally, today's maritime transport market is a buyer's market. The cargo owner has more discourse power in the market. After review of 5000 years history of world maritime transportation, Martine Stopford summarized: firstly, at every stage in its development, sea transport has figured prominently, and the shipping industry, with its distinctive international flavour, has played a central role; secondly, the basic economics of the business have not changed all that much over the years, in the process, shipping today has become more than ever before an integral part of the process of globalization; thirdly, shipping prospers during periods of political stability when the world is prosperous and stable, the lesson is that the starting-point for any future analysis is not economics but the geopolitical environment and where that is going.

[16] Data source: Compiled by the UNCTAD secretariat, on the basis of data from Clarkson Research Services.

2.2.2 The economic characteristics of global tanker market

If there were an attack on tankers in the Gulf, it is possible some tankers would be destroyed or significantly damaged thereby limiting the number of tankers available to transport oil in the global market. A shortage of tankers might cause the cost of shipping to increase, resulting in a spike in oil prices.

Review with Martine Stopford from end of World War II to 2008, global tanker market appeared to be a peak thick tail shape (Fig.2-9). The reasons for peaks are three factors: war, economy crisis and technology innovation. Most of peak distance is longer than 2 years.

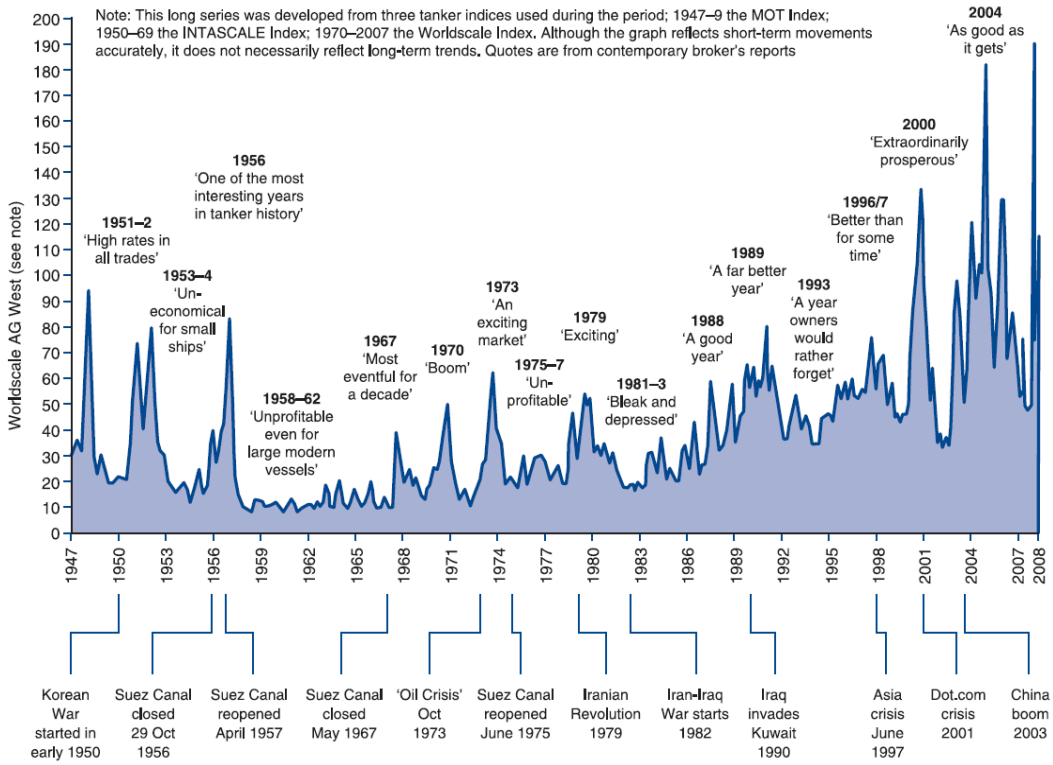


Fig.2-9 Global tanker market cycles (1947-2008)[17]

Global tanker market is driven mainly by top 20 oil companies, ranked by Forbes from 1 to 20: Saudi Aramco, Gazprom, National Iranian Oil Company, ExxonMobil, Rosneft, Royal Dutch Shell, PetroChina, Pemex, Chevron, Kuwait Petroleum Company, BP, Total, Petrobras, Qatar Petroleum, ADNOC (Abu Dhabi), Lukoil, Iraqi Oil Ministry, Sonatrach (Algeria), Pdvsa (Venezuela) and Statoil (Norway). Compared with 10 years ago, main companies in global oil market just have a few changes. Only three companies that were among the top 20 in 2003 are no longer there: Conoco Phillips (previously 16th) has jettisoned much of its international operations; Yukos (previously 13th) was nationalized by Vladimir Putin and its assets handed over to Rosneft; and Eni (previously 17th) has simply been surpassed as others have grown.

Main routes of tanker market are from Middle East to Far East (Japan and China), to North America (U.S. and Canada), to Europe, to India and Africa. Other main routes of tanker market

[17] Data source: Stopford M., 2009, Maritime Economics(3rd edition)

are from North and West Africa to Far East, to North America, to Europe and others (see Fig.2-10).

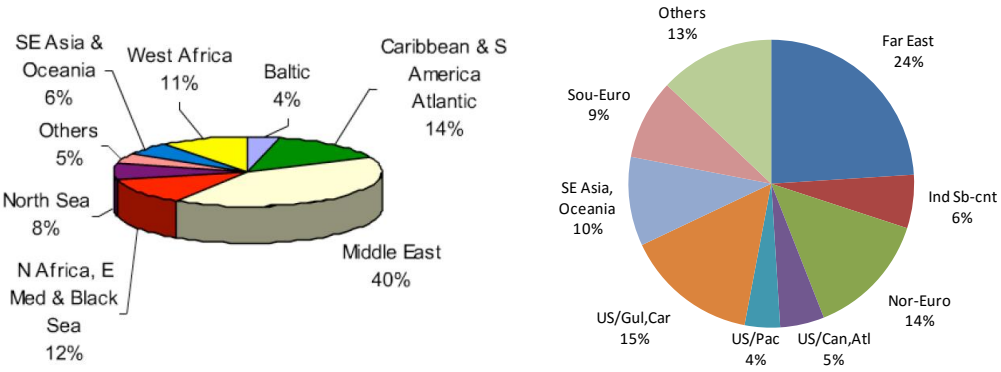


Fig.2-10 Global crude oil export (left) and import (right)

Crude oil transport volume from Mid-East to import countries in 2010 is showed in Fig.2-11.

The suppliers of tanker market are highly fragmented, with over 80 percent of the world fleet owned by independent tanker companies. The ten largest of these independent tanker companies own 26 percent of the world's fleet. Many private and state oil companies maintain their own fleets, owning in total 11 percent of the world's tankers. This fact means global tanker market is driven by buyers.

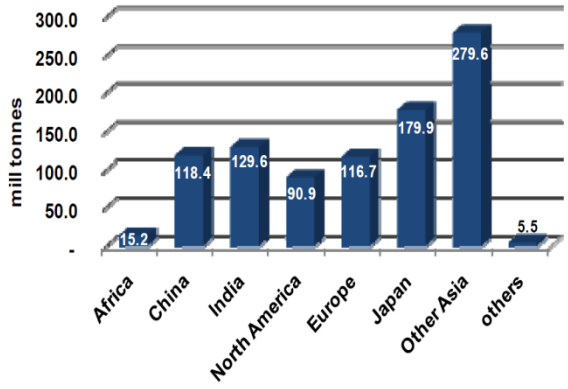


Fig.2-11 Crude oil transport volume from Mid-East by direction (2010)

Tankers are the most economically efficient means of intercontinental transport, as they maximize economies of scale based on volume per voyage. Numerous factors contribute to the cost of a tanker voyage - fuel is the largest component of a ship's operating costs. Other major operating costs include crew, repair and maintenance, insurance, stores, and administrative costs. Expenditures on crew represent the largest chunk of non-fuel operating costs.

The cost of transporting oil via tankers is influenced by the amount of slack capacity, or unused tankers, in the tanker market. The shipping industry considers 90 percent utilization of the tanker fleet "full utilization" because tankers must dock routinely for maintenance. While the tankers are docked, obviously, they cannot transport oil. Therefore, if more than 90 percent of the tanker fleet is needed to transport oil, transportation costs would likely to increase significantly.

Tab.2-3 Top 15 tanker companies (as of Jan.1, 2016)[18]

Ranking	Company	Kt (dwt)	Vessels
1	Teekay Corporation	18,275	137
2	Mitsui O.S.K. Lines	14,045	145
3	NIOC	13,520	54
4	SCF Group	12,076	125
5	Euronav NV	11,788	48
6	**NYK Line**	**11,635**	**86**
7	Bahri	11,209	62
8	China Merchants Grp	11,153	41
9	Fredriksen Group	10,912	55
10	Angelicoussis Group	10,680	41
11	Petronas	9,475	74
12	Dynacom Tankers Mngt	8,711	53
13	Ocean Tankers	7,788	87
14	China Shipping Group	7,480	70
15	COSCO Group	7,075	56

Top 15 tanker companies on the earth are listed in table 2-3. Eight of the top 15 tanker companies have background of monopoly Oil Company. Japan has MOL (rank 2) and NYK (rank 6) in the list as third crude oil import country and first LNG import country in the world. China has China Merchants Group (rank 8), China Shipping group (rank 14) and COSCO group (rank 15) in the list as second crude oil import country.

Facing to the monopolized buyers, independent tankers set up some alliances to coordinate their actions. As the international association of independent tanker owners, INTERTANKO created some indices showed in Fig.2-12. Tanker fleet index gives the scale of global tanker fleet. Oil demand index gives the volume of oil transportation. Tonne miles crude tanker index shows the demand of oil transport capacity. VLCC price index states the tendency of crude oil freight fee. Fig.2-12 indicates after the capacity of tanker fleet growth slower than the demand for some years, the freight fee rose rapidly during 1995-2006 when the capacity growth of tanker fleet is over the demand, the freight fee must decline quickly.

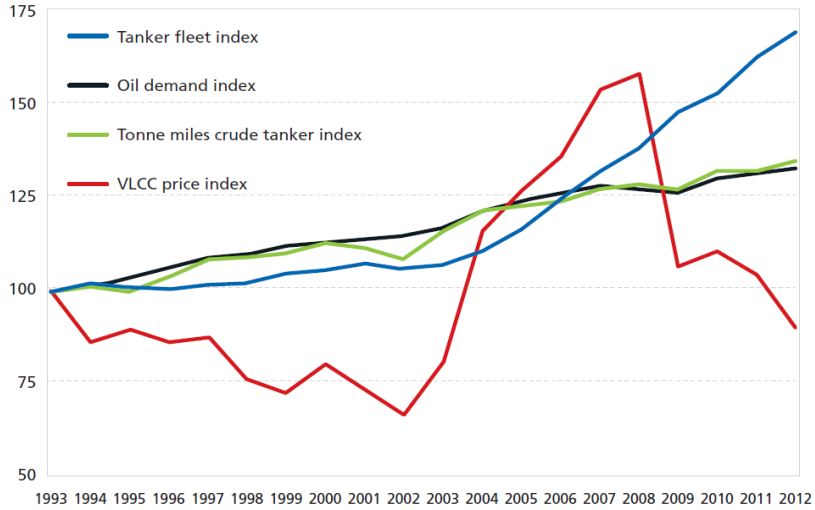


Fig.2-12 The tanker indices released by Intertanko[19]

[18] Data source: NYK Fact book I, 2016.
[19] Data source: Intertanko, 2013, Annual Review and Report 2012/2013, www.intertanko.com

2.2.3 The economic characteristics of global dry bulk market

Different with tanker market, global dry bulk market faces more kinds of cargoes like as iron ore, coal, grain, bauxite, etc.. The navigation routes and the types of vessel are more complex. For example, an iron ore carrier cannot carry grain when season demand rises for grain transport.

Reviewing with Martine Stopford from end of World War II to 2008, dry bulk market appeared to be a peak thicker tail shape (Fig.2-13). The number of peaks is obviously less than tanker market because of more competition in dry bulk market. The reasons for peaks are different with tanker market: war, cannel closed and economy booming of main economic body like China. Most of the peak distance is longer than 3 years, some are more than 10 years.

Iron ore, coal and grain are three main kinds of cargoes in dry bulk transport market. Some large shipping group companies own many types of ship to transport more kinds of cargoes. NYK, MOL, COSCO and China shipping Group are samples. Some middle and small scale shipping companies just focus on 1 or 2 kinds of goods like Tai Chong Cheang Shipping Group (TCC), a Hong Kong bulk carrier. So TCC only owns iron ore carriers and tankers.

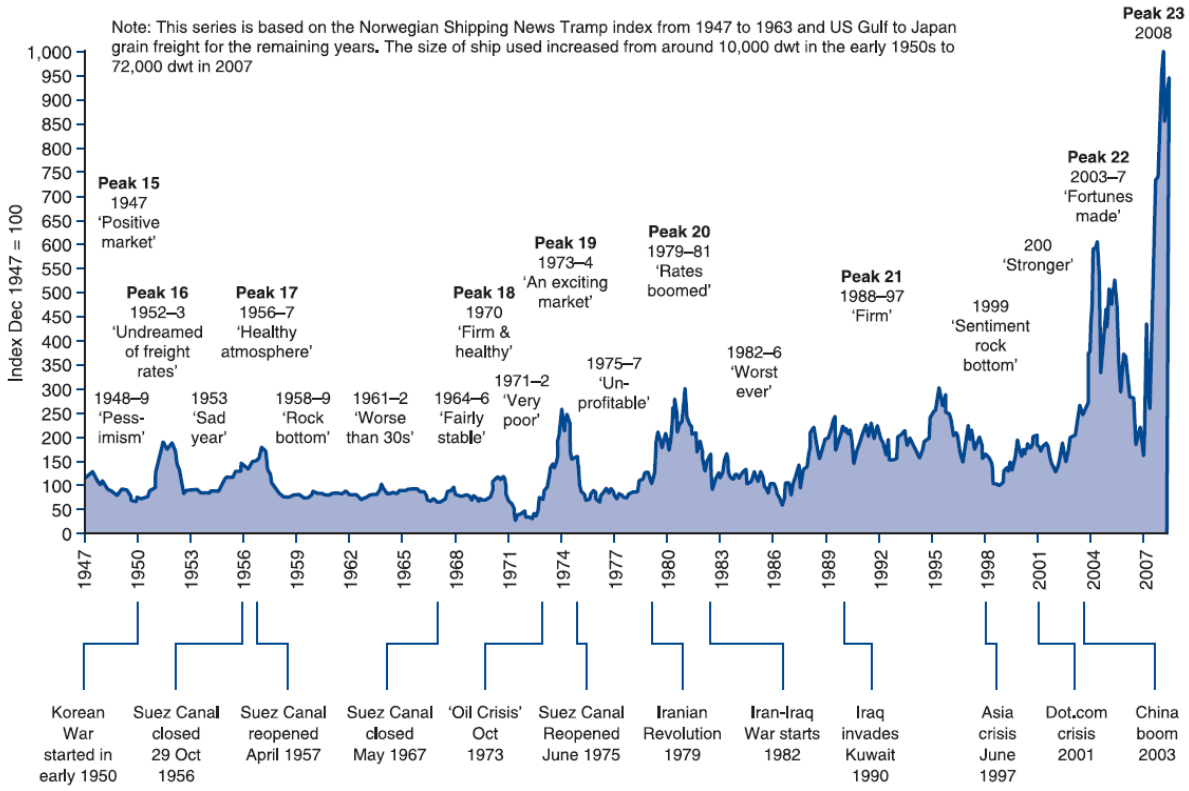


Fig.2-13 Global dry bulk market cycles (1947-2008)[20]

As a large scale shipping group, NYK set up a research department to give some research report on different shipping markets. To plan an optimized investment on vessels, the research department publish reports named NYK Fact Book scheduled. Fig.2-14 was the part of the 2016 reports.

[20] Data source: Stopford M., 2009, Maritime Economics(3rd edition)

Fig.2-14 Global dry bulk cargoes import and export volume (2008-2024)[21]

According to Fig.2-14 which is based on the data from Clarkson, the iron ore trade will grow slowly in next 8 years; grain trade growth is stable; coal trade will grow more quickly than others. So the demand for dry bulk carriers will be mainly from global coal trade, especially coking coal trade. Therefore, NYK will reduce the investment on iron ore carrier and grain ship.

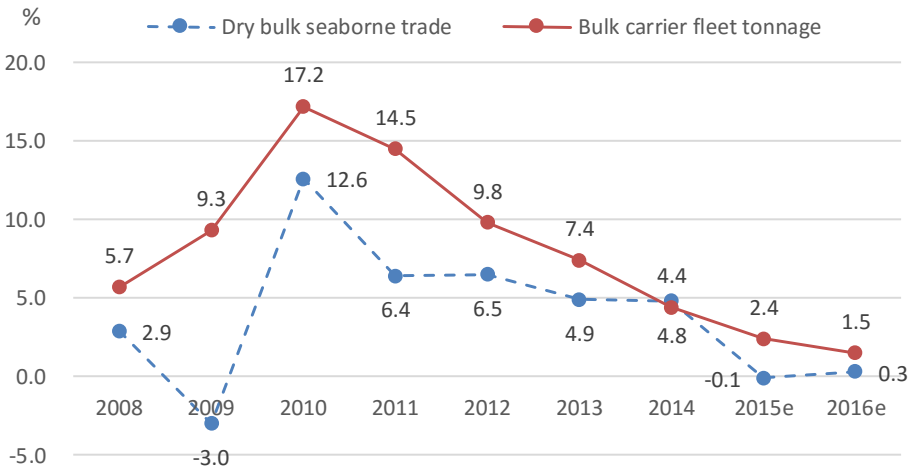


Fig.2-15 Increase in seaborne trade and fleet tonnage[22]

Fig.2-15 shows the reason that BDI is at lower position: in the situation of the excess supply in dry bulk market, the growth rate of bulk carrier fleet tonnage has been higher than dry bulk seaborne trade for at least 6 years except 2014. The data of 2015 and 2016 are estimates.

[21] Data source: NYK Fact book I, 2016.
[22] Data source: Shipping Intelligence Network (https://sin.clarksons.net/Timeseries)

Tab.2-4 Top 15 dry bulk carriers (as of Jan.1, 2016)[23]

Ranking	Company	Kt (dwt)	Vessels
1	Nippon Yusen Kaisha	20,996	226
2	COSCO Group	19,385	217
3	K-Line	15,703	135
4	China Shipping Group	11,506	134
5	Mitsui O.S.K. Lines	13,150	118
6	Fredriksen Group	9,168	86
7	Mitsubishi Corp	6,991	86
8	Pacific Basin Shpg	3,292	86
9	Imabari Shipbuilding	8,513	86
10	China Merchants Grp	7,924	84
11	Nissen Kaiun K.K.	8,030	81
12	Wisdom Marine Group	3,727	78
13	Star Bulk Carriers	7,362	70
14	Genco Shpg & Trading	5,157	70
15	Navios Group	6,808	68

Top 15 dry bulk carriers were listed in table 2-4. Top 5 are from China and Japan, the top 2 countries which import iron ore and coal. Australia, the biggest iron ore export country, has no the large scale dry bulk shipping company. Most of iron ore sales contract is exported from Australia with FOB rule. But Brazil, the second large export country, set up Vale shipping company which orders 12 plus 7 400 ~380 thousand deadweight VLOCs named Valemax to transport the iron ore to the gate of Far East area in 2008. Brazil wishes to sign iron export contract with CFR or CIF rule. This action enhances the competition in dry bulk market.

Both of buyer and seller in dry bulk market is more highly fragmented than other shipping market. There are too many buyers and sellers. In buyer's side, demands are from different cargoes, different countries and different companies. In seller's side, supplies are provided by different types of vessel, different carrier, different transport contract and different navigation routes. In this situation, shipping exchange was needed. Baltic Exchange with BFI system became more and more famous not only in dry bulk market but also in global maritime transport industry.

2.2.4 The economic characteristics of global liner market

Container was used in maritime transport first time in 1950s. Because of the high efficiency of loading and safety of the goods transportation, container and box vessel were promoted rapidly, although the investment of container fleet was very high. It was said that the container brought the revolution in transport market. No container, no intermodel transport, furtherly no third party logistics. The importance of containerization for global products trade has recently been re-emphasized. With the deepening of containerization process, over 95% of liner market is occupied by the standard boxes.

Alliance is one of the important characteristics of the global liner market. After "Convention on a code of conduct for liner conferences" (UN 1980), liners companies used to organize various alliances to enhance their competitive power. Even top 2 liner, Maersk Liner and MSC set up the 2M alliance. The members of G6 Alliance are APL, NYK, MOL, OOCL, HMM and Hapag-Lloyd.

[23] Data source: NYK Fact book I, 2016.

The members of CKYHE alliance are COSCO, K-Line, Yangming, Hanjin and Evergreen. The member of these alliances always change in different market environment.

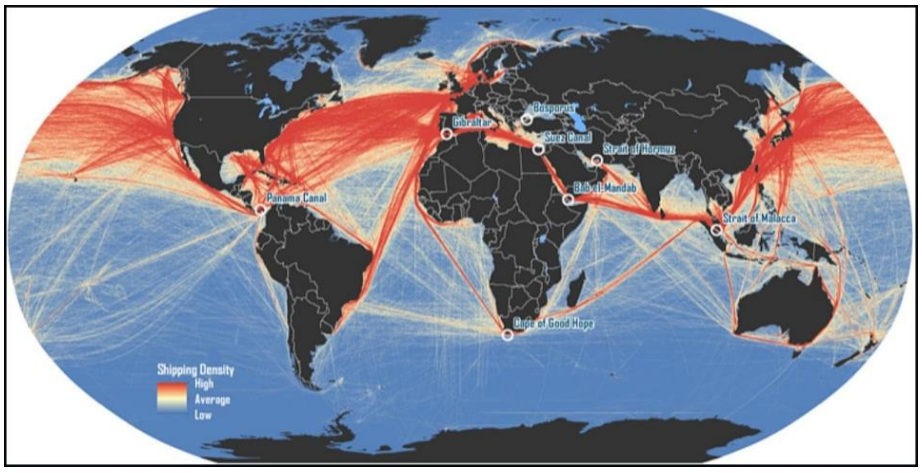


Fig.2-16 The density of container liners on the Earth[24]

Fig.2-16 shows the density of container routes on the Earth now. These routes became the bridges on the oceans that connect continents. They give the international products trade very strong support.

The last 10 years have seen two important trends, which represent two sides of the same coin. On the one side, ships are becoming bigger, and on the other side the number of companies in most markets is diminishing (Fig.2-17).

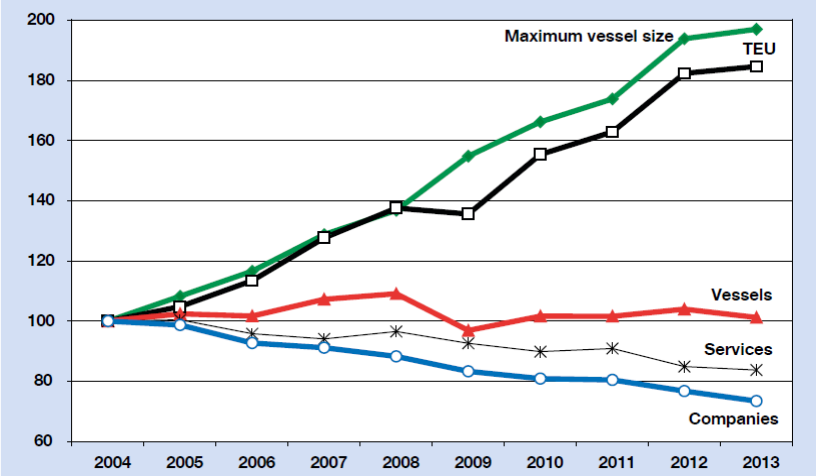


Fig.2-17 Trends in container-ship fleet deployment[25]
(Index =100 for 2004, data for mid-2004–mid-2013)

As regards to the number of companies, the average per country has decreased by 27 per cent during the last 10 years, from 22 in 2004 to just 16 in 2013. This trend has important implications for the level of competition, especially for smaller trading nations. While an average of 16 service providers may still be sufficient to ensure a functioning competitive market with many choices for shippers for the average country, on given individual routes, especially those serving smaller

[24] Data source: OECD: International Transport Forum 2010
[25] Data source: UNCTAD, based on data provided by Lloyds List Intelligence

developing countries, the decline in competition has led to oligopolistic markets. For example, in 2004 there were 22 countries served by three or fewer carriers, while in 2013, 31 countries were facing such a less-than-desirable situation. Even on the main East-West routes, analysts have expressed concerns that shippers will be confronted with less choice, as medium-sized carriers are squeezed out of the market.

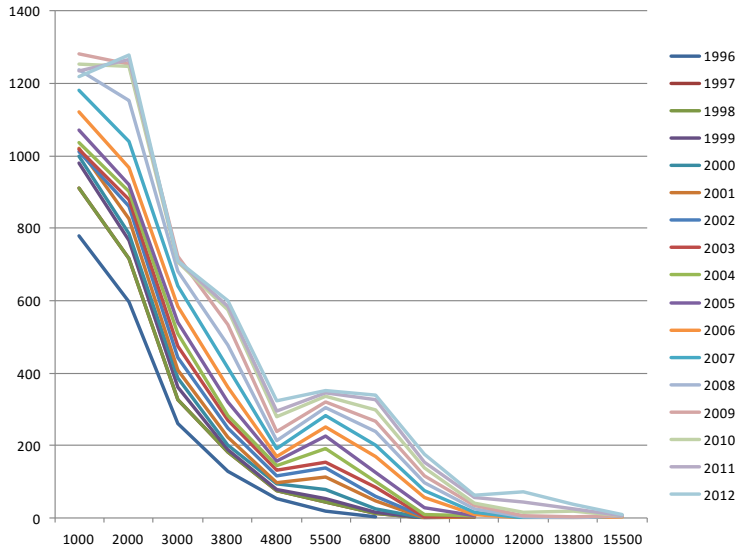
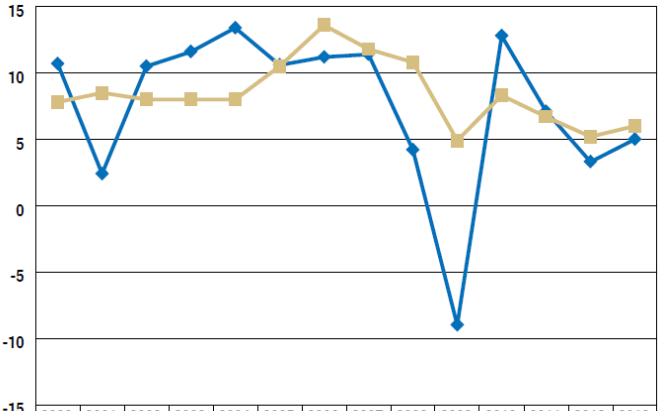


Fig.2-18 Vessel load capacity and its number (1996-2012)[26]

As regards to vessel sizes, since 2004 the average container-carrying capacity of the largest ship in the 159 countries covered by UNCTAD's database has almost doubled, from 2,812 TEU 10 years ago to 5,540 TEU in 2013. The size of the largest existing ships has also almost doubled during these 10 years (from 8,238 to 18,800 TEU). Fig.2-18 describes the number of every load capacity ship which have been put into operation every year (1996-2012).



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Demand	10.7	2.4	10.5	11.6	13.4	10.6	11.2	11.4	4.2	-9.0	12.8	7.1	3.3	5.0
Supply	7.8	8.5	8.0	8.0	8.0	10.5	13.6	11.8	10.8	4.9	8.3	6.7	5.2	6.0

Fig.2-19 Growth of demand and supply in container liner (Annual growth rates)[27]

[26] Data source: Shipping Intelligence Network (https://sin.clarksons.net/Timeseries)

[27] Compiled by the UNCTAD secretariat on the basis of data from Clarkson Container Intelligence Monthly, various issues.

Fig.2-19 illustrates, in past 14 years, the growth rate of container service demand was higher than supply just for 7 times, looks like a tie. But the average growth rate of supply for 14 years is 8.435%, and demand is 7.514%. So the growth of supply capacity is higher than the demand. The shape of supply growth is more stable than demand. This phenomenon indicates that the liner companies can better control the capacity growth.

Tab.2-5 Top 20 liner companies (as of Jan.1, 2015)[28]

Rank	Operator	Market share % (TEU)	TEU	Vessels	Average vessel size	Orderbook TEU	Orderbook vessels	Average vessel size orderbook
1	Maersk Line A/S	13.45	2 526 490	478	5 286	91 080	9	10 120
2	Mediterranean Shipping Company (MSC) SA	13.22	2 483 979	451	5 508	498 680	36	13 852
3	CMA CGM S.A.	8.00	1 502 417	375	4 006	182 500	16	11 406
4	Evergreen Marine Corporation (Taiwan) Limited (Evergreen Line)	5.08	954 280	204	4 678	354 000	23	15 391
5	COSCO Container Lines Limited (COSCON)	4.55	854 171	158	5 406	119 500	10	11 950
6	China Shipping Container Lines Company Limited	4.00	751 507	136	5 526	19 100	1	19 100
7	Hapag-Lloyd Aktiengesellschaft	3.90	732 656	145	5 053	0	-	
8	Hanjin Shipping Company Limited	3.41	640 490	104	6 159	0	-	
9	Mitsui O.S.K. Lines Limited (MOL)	3.19	599 772	111	5 403	122 300	6	20 383
10	APL Limited	2.91	545 850	96	5 686	0	-	
11	Orient Overseas Container Line Limited (OOCL)	2.77	520 328	103	5 052	143 656	8	17 957
12	Hamburg Sudamerikanische Dampfschifffahrts-Gesellschaft KG	2.66	498 902	104	4 797	0	-	
13	Nippon Yusen Kabushiki Kaisha (NYK)	2.63	494 953	104	4 759	112 000	8	14 000
14	Yang Ming Marine Transport Corporation	2.60	487 771	103	4 736	182 000	13	14 000
15	Hyundai Merchant Marine Company Limited (HMM)	2.13	399 791	65	6 151	60 000	6	10 000
16	Kawasaki Kisen Kaisha Limited ('K' Line)	2.12	397 623	77	5 164	110 960	8	13 870
17	Pacific International Lines (Private) Limited (PIL)	1.99	374 849	139	2 697	22 905	6	3 818
18	United Arab Shipping Company (S.A.G.) (UASC)	1.98	372 841	53	7 035	214 300	13	16 485
19	Zim Integrated Shipping Services Limited	1.58	296 554	66	4 493	0	-	
20	Compania Sud Americana de Vapores S.A. (CSAV)	1.26	237 567	40	5 939	18 000	2	9 000

Tab.2-5 gives the rank of top 20 global liners in Jan. 2015. Big 3 are European companies. They have 34.67% share of supply in the global market (33.5% in Jan. 2013). The data shows their monopoly position in global liner market has enhanced in last two years. Although there are

[28] Data source: UNCTAD. 2015, Maritime Transport Review 2015

12 East Asian liner companies with 37.38% share in the market, like COSCO, Evergreeen, CSCL, Hanjin, MOL, OOCL, NYK, HMM, Yangming, K Line and PIL, they were unable to form a unified liner company alliance due to political factor. In this situation, the share of Asian liner companies became smaller with more product export.

2.2.5 Summary

The maritime transport market is a globalized market. This market can be divided into several parts according to the nature character of cargoes and its business model. Tanker market, dry bulk market and liner market are three kinds of main types. All of them are in accordance with the operation of the market. The balance of supply and demand is the basic rule of this market. As the mechanism of markets is different, the types of market are different. The dry bulk market is very close to perfect competition market, the tanker market is very close to buyer monopoly market, the liner market is very close to seller monopoly market.

Modern technology promotes the implementation of the large-scale ship. Meanwhile, carbon emission and unit cost of maritime transport are reduced.

Chapter 3 Index Framework Design for Maritime Transport Market

This chapter introduces the present indices in the global maritime transport market first with their producers, functions and methodologies. Then the index framework is designed with multi lever structures including freight index, earning index and prosperity index following the structure analysis of the maritime transport market in chapter 2. Furtherly, based on the development of e-shipping and e-commerce, the possibility of these indices are discussed qualitatively.

3.1 Present indices in the global maritime transport market

Although maritime transport started before thousand years, first index product of maritime transport appeared after World War II. The freight index was the early products as there was strong demand in voyage charter market for dry bulk and liquid bulk transportation. Brokers are the inventors of these indices products. In this section, the organizations which issue the indices will be introduced first. Then the picture of maritime transport indices will be sketched.

3.1.1 Organizations which issue the indices

A lot of experts and scholars pay attention to the maritime transport freight tendency. People design different systems to find the change rule of maritime transport freight. The Baltic Exchange is a good example. Others are like Clarkson, SSY, ICAP, Worldscale, Drewry, etc. The Shanghai Shipping Exchange announce to do same business with the Baltic Exchange, but they are totally different in mechanism and business.

(1)The Baltic Exchange

The Virginia and Maryland coffee house in Threadneedle Street changed its name to Virginia and Baltick in 1744. This reflected the business of the merchants and shipowners who regularly gather there. The Baltic Company Limited was formed in 1857 meanwhile new rules and a committee of 30 was introduced. The London Shipping Exchange became part of the Baltic Exchange in 1900. The Baltic Freight Index was launched - the first in a series of freight market indices produced by the Baltic in 1985. The world's first freight futures market was launched allowing ship owners and charterers the ability to protect themselves from fluctuating freight rates.

The Baltic developed into the world's most prestigious and only international, self-regulated market for matching ships and cargoes and buying and selling ships. Although in the light of modern business practice and international communications a trading floor is no longer necessary, the Baltic's global members continue to operate as a shipping marketplace and to apply the highest standards of ethics.

A large part of the world's maritime cargo chartering and sale and purchase business is negotiated at some stage by members of the Baltic. The Baltic publishes numerous daily indices which indicate the state of the markets. As well as providing guidance to brokers these form the settlement mechanisms in the Forward Freight Agreement (FFA) market which is used for risk management.

At the time of writing in 2012 Baltic members represented worldwide interests through over 600 companies. Around 2,400 men and women represent these companies on the Exchange, all individually elected to do so. There are some 63 different nationalities represented on the

Exchange.

(2)Clarksons

The company was founded by Horace Anderton Clarkson in London in 1852. Son of a prosperous lawyer, he invited Leon Benham, a former colleague, to join him in partnership. Leon's son Henry soon joined the business. In the 1850s the business involved sailing ships, but by the 1860s the company was chartering steam ships. In 1872 Clarksons became shipowners with the acquisition of three schooners.

The company became the world's largest tanker broker in 1929 when Esso appointed Clarksons as its exclusive shipbroker. The first overseas office opened in New York in 1954. Offices soon followed in France, Australia and Germany, and in the 1960s, South Africa and Greece. Expansion in the Far East began in the 1990s when, through Clarkson Asia, companies were established in Hong Kong, Shanghai and Singapore.

The company spun off various diversified assets as Shipping Industrial Holdings in 1974.

Until March 2012, Professor Martin Stopford sat on the board of directors and was head of the research arm of the company. Clarkson Research Services Limited provides a statistical and research service to Clarksons, its clients and the shipping world in general. Its large research team compiles and interprets data on the world's cargo and offshore fleets of over 80,000 vessels on a daily basis, including technical features, freight rates, ship prices and cargo/economic statistics.

Research into commercially important aspects of key sectors of shipping is carried out by staff appropriately qualified to assist in the industry's decision-making process. As well as providing Clarkson's brokers with an extensive and up to the minute flow of data to support their negotiations, Clarkson Research Services supplies quality market intelligence to shipping, banking and investment interests all over the world.

(3)SSY

As the world's largest independent shipbroking group, SSY is an organic and dynamic organization that combines over a century of traditional broking expertise with technological sophistication and innovation. SSY takes pride in a pro-active approach to broking and advises their clients to future market trends, developments and opportunities as well as anticipating their growing and changing requirements.

As the shipping market never sleeps nor does SSY’s global coverage which spans sixteen countries and offers a comprehensive range of services. These include: ①Agency and Towage, ②Research, ③Freight Futures, ④Dry Cargo Chartering, ⑤Tanker Chartering, ⑥Chemical Chartering, ⑦Sales and Purchase and ⑧SSY Valuation.

SSY's Consultancy & Research team is one of the most respected in the industry. It prides itself on both the quality of its data and the depth of its market analysis. One of the team's strengths is the scope of its trade data in both dry cargoes and oil, built up over a number of years. SSY is a primary source of trade and fleet data, freight rate and market assessments. Data is compiled through customs & official statistics, direct market information and in co-operation with other information providers. SSY’s dedicated team of market analysts is involved in commodity demand & trade forecasting, earnings forecasting, investment appraisals and the identification of investment opportunities. The Consultancy & Research team works closely with the SSY broking teams and their clients by providing presentations, reports and advice. In addition commercial

consultancy studies are undertaken on behalf of numerous external bodies.

Vessel valuations are SSY's field of expertise and its experienced team work closely with all sectors of the industry including shipowners and financial institutions worldwide. All valuations are carried out with due diligence and in accordance with ISO procedures.

(4)ICAP

ICAP is a leading markets operator and provider of post trade risk mitigation and information services. Efficient financial markets are vital to global and national economies. As a leading markets operator, ICAP provides a wide variety of electronic execution, risk mitigation, messaging, broking and information services for wholesale market participants. ICAP facilitates the flow of capital and investment through the financial system and supports government and corporate borrowing.

In May 2007, after a successful joint venture in freight derivatives, ICAP acquired J E Hyde, one of London's oldest shipbrokers. This was followed by the acquisition of Capital Shipbrokers in 2008 and the formation of ICAP Shipping. Offering a spectrum of shipping services, including dry and wet cargo chartering, sale and purchase, freight derivatives, research and operations, ICAP Shipping operates out of London, Copenhagen, Gibraltar, Hamburg, Shanghai, Singapore and Athens.

ICAP Shipping's Freight Derivatives desk combines strong financial brokerage experience with focused knowledge and insight into freight derivative procurement and marketing. ICAP industry expertise allows the shipbroking sector to source, market and facilitate transactions of standard and non-standardised specifications and deliveries. The shipbroking sector has changed dramatically over the past few years and interest has deepened. ICAP Shipping is in a strong position to further the global reach and opportunities for customers in these rapidly growing markets.

The combination of the shipbroking expertise of J.E. Hyde and Capital Shipbrokers with ICAP's proven track record for broking complex global markets creates a business with over 130 years of shipbroking experience, an unrivalled contact book and exceptional market knowledge.

(5)Worldscale association

The concept of freight rate schedules was originated by first the British Government and later the U.S. Government during the 1939-1945 war for requisition shipping and Owners received compensation on the basis of a daily hire rate.

The last schedule of tanker voyage rates to be issued by the British Ministry of Transport gave rates effective 1st January 1946 and this schedule became known simply as "MOT". Similarly, the last rates to be issued by the United States Maritime Commission, which took effect from 1st February 1946, became known as "USMC".

Between 1952 and 1962 a number of different schedules were issued as a service to the tanker trade by non-governmental bodies; Scales Nos. 1, 2 and 3 and then Intascale in London, ATRS in New York.

Then in 1969 there came the joint London/New York production issued to replace both Intascale and ATRS called the "Worldwide Tanker Nominal Freight Scale", more usually know under its code name "Worldscale".

Finally, "New Worldscale" was introduced with effect from 1st January 1989. However, in

deference to the custom that emerged in the trade, the epithet "new" was soon dropped and now it is generally understood that "Worldscale" refers to the new scale, while the previous scale is called "Old Worldscale".

Both "Worldscales" are the joint endeavour of two non-profit making organisations know as Worldscale Association (London) Limited and Worldscale Association (NYC) INC. NYC standing of course for New York City. Each company is under the control of a Management Committee, the members of which are senior brokers from leading tanker broking firms in London and New York respectively. New York represents North, Central and South America, Caribbean Islands, Bermuda, Greenland and Hawaii. London represents for the rest of the world.

Members of Worldscale Association (London) Limited consist of SSY, Clarksons, Galbraith's Limited, E.A. Gibson Shipbrokers Limited, Braemar Seascope Limited and ACM Shipping Limited. Members of Worldscale Association (London) Limited consist of McQuilling Brokerage Partners Inc, Mallory Jones Flynch & Associates Inc, Odin Marine, Poten & Partners, Charles R. Weber Company and Dietz & Associates Inc. Most of the members are ship brokers.

(6) Howe Robinson

Howe Robinson and Company was established in London in 1883. It has since grown into one of the largest privately-owned dry-cargo and containership broking houses in the world, with a global network of 6 offices employing over 100 brokers.

Since a management buyout in 1988, the group has enhanced its position in the ship broking market through a combination of mergers such as that of Angus Graham in 2006, and strategic acquisitions such as those of Erlebach in 1992, Lambert Brothers in 1996, Killick Martin in 2007 and Shyvers Savoy Shipping in 2012.

Within Howe Robinson Shipbrokers, specialist desks work in all the key segments of the dry cargo market with each department providing global coverage. Similarly all areas of the container market are covered by teams of experienced brokers.

Howe Robinson Sale and Purchase and New Building departments handle the Group's activities in second-hand, new buildings and demolition of Containerships and Bulk Carriers. Vessel and fleet evaluations are handled through Howe Robinson Marine Evaluations Ltd.

Howe Robinson Hong Kong opened in 1992 to establish a presence on the expanding Asian market and develop further Howe Robinson's established connections with China and Hong Kong which date back to the 1950s. Howe Robinson Tokyo office followed in 1996, providing broking services to Mitsui and other major Japanese shipping companies. Howe Robinson opened an office in Shanghai in 2002 which has now expanded to provide chartering coverage to all the leading owning and cargo interests in Containers and Dry Bulk within China. During 2005 Howe Robinson Hamburg was established to serve the German maritime industry in Dry Cargo, Containers and New Buildings.

Recognising the increasing importance of Singapore as a hub for the fast growing South East Asia region, Howe Robinson relocated its head office to Singapore in 2009.

Howe Robinson is a member of the Baltic Exchange in London and a Panel Member reporting daily on all the Dry Bulk Baltic Exchange Indices.

(7) Drewry

H.P Drewry Ltd is the world's foremost independent global maritime advisory and research

organisation. The company is privately owned and from their offices in London, Delhi, Singapore and Shanghai, supported by associates across the world, delivers world-class support anywhere, anytime. It was founded in 1970 to provide information and advice to the global maritime industry it has since then worked with over 3,000 clients in more than 100 countries.

Throughout the 1970s and 1980s the publishing base of Drewry was expanded as new products, such as single client advisory work, were added to the portfolio. The company also expanded into other markets adding new sectors such as containers, ports and shipbuilding.

During these formative years much work was undertaken to build the company's information and knowledge bases and during this time the Drewry brand became well established. In April 2000, a management buy-out took place. This allowed Drewry to diversify and to launch new businesses supporting client needs across a broader base of maritime activities including ports, terminals and logistics. They have also opened offices in India, Singapore and China and with these, coupled with their network of associates across the World, Drewry now operates on a global platform.

Drewry has four main research departments. ⑴Drewry Maritime Research provides regular analytical market reports of the global maritime sector, giving valuable and independent information and analysis which is critical for informed decision making. ⑵Drewry Maritime Advisors provides robust analysis and actionable advice and recommendations. The bespoke service has its foundations in their research, but it is defined by their breadth of expertise, sector adaptability and international capabilities. ⑶Drewry Supply Chains provides bespoke advice that extends beyond the maritime element of a supply chain, thereby offering end-to-end solutions for commercial organisations. ⑷Drewry Maritime Equity Research offers investment reports of listed companies in the maritime sector. Authorised by the UK FCA their reports are an independent source to assist clients to make decision.

(8) Bloomberg L.P.

Bloomberg was set up by Salomon Brothers and Michael Bloomberg in 1981, having designed in-house computerized financial systems. Bloomberg developed and built the Innovative Market Systems (IMS) own computerized system to provide real-time market data, financial calculations and other financial analytics to Wall Street firms. In 1983, Merrill Lynch invested $30 million in IMS to help finance the development of "the Bloomberg" terminal computer system and by 1984, IMS was selling machines to all of Merrill Lynch's clients.

In 1986, the company was renamed Bloomberg L.P., and 5,000 terminals had been installed in subscribers' offices. Within a few years, ancillary products including Bloomberg Tradebook (a trading platform), the Bloomberg Messaging Service, and the Bloomberg newswire were launched. Bloomberg launched its news services division in 1990. Bloomberg.com was first established on September 29, 1993 as a financial portal with information on markets, currency conversion, news and events, and Bloomberg Terminal subscriptions.

Since his founding, Bloomberg L.P. has made several acquisitions including the radio station WNEW, BusinessWeek magazine, research company New Energy Finance, the Bureau of National Affairs and the financial software company Bloomberg PolarLake.

Its products include ①Bloomberg Professional Service, ②Bloomberg News, ③Bloomberg Television, ③ Bloomberg Markets, ④ Bloomberg Government, ⑤ Bloomberg Law, ⑥

Bloomberg View, and ⑦Bloomberg Tradebook. In shipping area, Bloomberg pays more attention to investment value for the shipping and port enterprises.

(9) Shanghai Shipping Exchange

Shanghai Shipping Exchange (SSE), jointly founded by the Ministry of Traffic and Transport and Shanghai Municipal People's Government on November 28 1996 under the approval of the State Council, is the first state-level shipping exchange in China. The founding of the SSE represents a major step taken by the Chinese government to promote, invigorate China's shipping market and match the target of the construction of Shanghai International Shipping Center.

The SSE governs six departments: the Information Department, the Trading Department, the Technical Department, the Marketing Department, the Financial Department and the Presidential Administration Office.

SSE is gifted with the basic functions as " to standardize the transactions, to adjust the freight rates, and to communicate information on the shipping market." By performing these three functions and sticking to the principle of "Openness, Fairness and Justness", SSE has scored fruitful achievements in information exchange and research, shipping operator credit evaluation system, shipping trading, notarization and services to port and shipping industry especially her member entities.

At present, SSE is making full use of the opportunities of shipping development and concentrating on embodying the trading function of key shipping elements by possessing and publicizing of shipping information, promotion of shipping conventions, research of shipping policies, exchange of shipping business, broking service, consulting and agency service, formulation of example documents and standardization of shipping market.

For the purpose of meeting the demand of international container freight index derivative and optimizing China's export container freight index system, Shanghai Shipping Exchange renovates and publicizes Shanghai (Export) Containerized Freight Index (SCFI), which is officially issued on October 16th 2009 to replace the original SCFI issued on December 7th 2005.

For fully reflecting the fluctuation of Chinese coastal transport market, the SSE officially initiated China Coastal Bulk Freight Index (CBFI) on 28th November 2001, the China (Coastal) Bulk Coal Freight Index (CBCFI) on 1st September 2011, China Import Dry Bulk Freight Index (CDFI) on 28th November 2013, China Import Crude Oil Tanker Freight Index (CTFI) under the guidance of MOT.

(10) Lloyd's List

Lloyd's List was founded by Edward Lloyd, who posted details of ship arrivals, departures and casualties on the wall of his coffee shop for the benefit of London's 18th Century maritime community. It is one of the world's oldest continuously running journals, having provided weekly shipping news in London as early as 1734. Now published daily, a recent issue was numbered 60,850 (2013). The newspaper survives today to fulfill a similar purpose, although its circulation is now international, both paper and web-based, and it appears daily. As well as shipping news, Lloyd's List today covers marine insurance, offshore energy, logistics, global trade and law. It boasts that for the shipping industry, the paper is "sometimes its conscience, too". Its timely international casualty reports, however, continue to be one of the paper's most important features, and are updated frequently in the Internet edition.

Lloyd's List is produced by the division of Informa Maritime & Transport which handles maritime information for the entire group now. Informa Plc is an international business in the media sector and listed on the London Stock Exchange. As a part of Informa Plc, Informa Maritime & Transport sells maritime information such as the Lloyd's List to corporations in 134 countries. It is a publisher of 30 market leading newspapers and trade magazines for the maritime and transport sector. Their publishing products include Cargo Systems, International Freighting Weekly, Lloyd's Cruise International, Lloyd's Ship Manager, Ship Care, Containerisation International and Lloyd's Shipping Economist.

Lloyd's List Intelligence provides an interactive online service offering detailed vessel movements, real-time AIS (Automatic Identification System) positioning, comprehensive information on ships, companies, ports and casualties as well as credit reports, industry data and analysis including short-term market outlook reports. Lloyd's List Intelligence also provides a range of support services such as in-depth consultancy, investigations, due diligence, market trend analysis and credit risk appraisal for entire portfolios. Lloyd's List Intelligence has a global presence with principal offices located in the UK, US, Singapore and Australia. In addition, Lloyd's List Intelligence directly employs expert analysts and researchers in Greece, India, Canada and China. Its unique global network of specialist sources also includes the Lloyd's Agency Network of 700 agents and sub-agents for vessel movements' data, the leading registries and classification societies for vessel characteristics, and major company registries around the globe for corporate data.

(11) Summary

The table 3-1 gives a summary for the character of the organizations above. It is easy to find that most of publishers of shipping indices are located in London, UK. Brokers are the main data sources for calculating the indices. Next step is to give the reason for this phenomenon by the analysis of shipping indices.

Tab. 3-1 the Character of the Organizations

Organization	Location	Data Source	Products	Owner
Baltic Exchange	London	Members	Shipping Freight Indices, FFA	Joint stock
Clarkson	London	Brokers	Clarksea Indices, Consultancy, Research Report	Joint stock
SSY	London	Brokers	Consultancy, Research	Partners
ICAP	London	Brokers	Freight Derivatives	Joint stock
Worldscale Association	London, New York	Carriers, Brokers and Shippers	WS	Joint stock
Howe Robinson	London	Brokers	Consultancy, Research	Partners
Drewry	London	Brokers	Consultancy, Research	Joint stock
Bloomberg L.P.	New York	Stock Market	Magazine, Research Report and web	Joint stock
Shanghai Shipping Exchange	Shanghai	Carriers	CCFI, SCFI, CBCFI, CTFI	State-owned
Lloyd's List	London	Investors, Specialist and Brokers	Informa Maritime & Transport, Lloyd's List Intelligence, APP	Joint stock

3.1.2 Introduction of main indices in maritime transport market

Since tanker was put into operation in the late nineteenth Century, the maritime transportation market is divided gradually into four parts: tanker market, dry bulk market, container liner market and others. Corresponding to this, most of shipping indices is focused on certain submarket, like the WS focuses on tanker market, the BDI focuses on dry bulk market, etc..

⑴Indices in tanker market

Tanker market started in 1870s with first tanker launched. Most of tanker indices is about freight. In tanker market, ship owner usually rents a vessel to shipper for one or several voyages between certain ports, or for particular time with safety ports. Voyage charter is for voyage and time charter is for time. The substance of transport is freight rate in voyage charter. The substance of transport is chartering rate in time charter. Therefore, most freight indices are made from two kinds of freights: freight rate and chartering rate. The best data source is the broker who helps ship owner and shipper make the chartering contract.

There are some freight indices lists in the table 3-2 that focus on tanker freight market. Actually, these indices are relative. The WS gives the data source for others. SSY, Clarkson and other brokers use them to edit different tanker indices in their way like the PFR or the PTSE. This kind of index is very similar to the chartering rate which could persuade their customers reach freight clause in the charter contract. The Baltic Exchange calculates the BDTI and the BCTI to give the freight tendency of the tanker market by using the data of the WS as its aim is the FFA.

Tab. 3-2 Freight indices in tanker market

Full Name	Abbreviation	Unit	Producer	Time	Type of Vessel
Baltic Dirty Tanker Index	BDTI	-	Baltic Exchange	daily	Dirty Tanker
Baltic Clean Tanker Index	BCTI	-	Baltic Exchange	daily	Clean Tanker
Crude Freight Rates	CFR	USD /day	SSY	daily	VLCC, Suezmaxe, Aframaxe
Product Freight Rates	PFR	USD /day	SSY	daily	Clean Products, Dirty Products
Crude Tanker Spot Earnings	CTSE	USD /day	CSRL	daily	VLCC, Suezmaxe, Aframaxe
Product Tanker Spot Earnings	PTSE	USD /day	CSRL	daily	Clean Products, Dirty Products
New Worldwide Tanker Nominal Freight Scale	WS	-	Worldscale	daily	147 spot rates for tanker market
China Import Crude Oil Tanker Freight Index	CTFI	USD /day	SSE	testing	VLCC

For example, the Clarksons Average Tanker Earnings (CATE) is issued by the Clarkson Research Services Ltd (CRSL). The CRS calculates the CATE daily based on the tanker transport parts of the WS and some data given by the broker partners by using a weighted method. The unit

of the CATE is USD/day so that to be understood and compared easily in time charter. Fig.3-1 shows the curve of the CATE ((Jan. 1990-Dec. 2015).

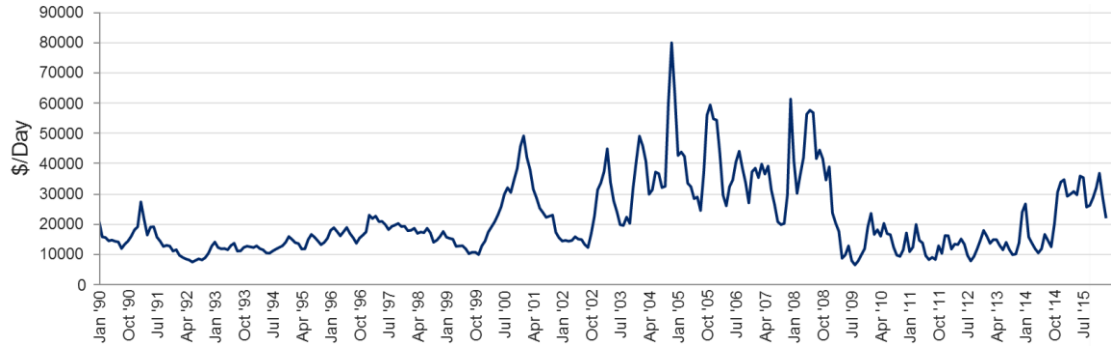


Fig. 3-1 The Clarksons average tanker earnings (Jan. 1990-Dec. 2015)[29]

BDTI was designed at end of 20th Century later than CATE. Baltic Exchange makes it a tool for FFA. So it must be dimensionless and standardized. BDTI is calculated daily based on the product dirty oil transport parts of WS and some data given by the members of the Exchange by using a weighted method. Fig. 3-2 shows the change of BDTI (Aug.1998 - Feb. 2016).

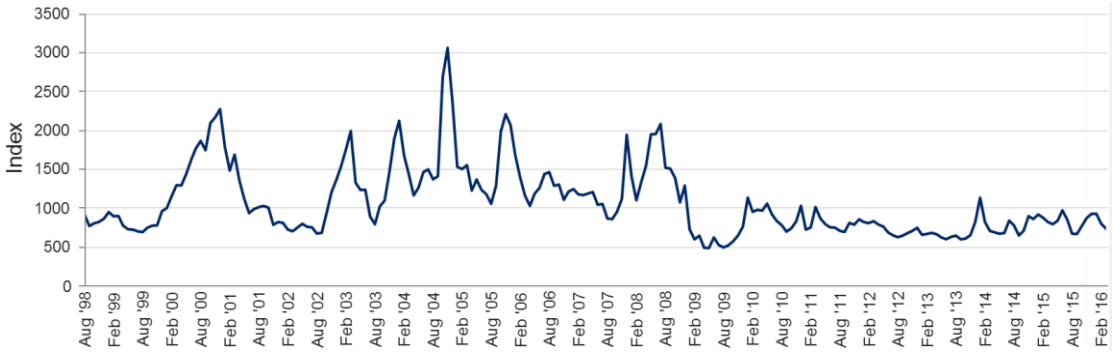


Fig. 3-2 The Baltic dirty tanker index (Aug.1998-Feb. 2016)[30]

China Tanker Freight Index (CTFI) also depends on WS and real data from Chinese tanker fleet operators like as COSCO, China Merchants Energy Shipping and China Shipping Development. As the data source is very limited, CTFI just focuses on two routes related with China, one is Mid-east to Ningbo and another is West Africa to Ningbo. CTFI is still in testing process.

(2) Indices in dry bulk market

Dry bulk market started in 1890s with first coal carrier vessel launched. Although the type of vessel is different, dry bulk market has same freight structure with tanker market. As dry bulk cargo is not such important as oil, in dry bulk market, there is no any stable data source like WS in tanker market. SSY, Clarkson and other broker organizers have to set up their own databases to issue the freight indices themselves. Every chartering contract became original data source. Baltic Exchange designed a set of dry bulk freight indices to meet different demand on the market by

[29] Data source: Shipping Intelligence Network (https://sin.clarksons.net/Timeseries)
[30] Data source: Shipping Intelligence Network (https://sin.clarksons.net/Timeseries)

combining these data from his broker members. Dry Bulk Carriers are divided into several parts and given image names like as Capsize, Panamax, Handysize and Supramax, etc. The table 3-3 gives classic freight indices in global dry bulk market.

Tab. 3-3 Freight indices in dry bulk market

Full Name	Abbreviation	Unit	Producer	Time	Type of Vessel
Baltic Dry Index	BDI	-	Baitic Exchange	daily	Dry Bulk Carrier
Baltic Capsize Index	BCI	-	Baitic Exchange	daily	Capsize Carrier
Baltic Panamax Index	BPI	-	Baitic Exchange	daily	Panamax Carrier
Baltic Handymax Index	BHMI	-	Baitic Exchange	daily	Hangdymax Carrier
Baltic Handysize Index	BHSI	-	Baitic Exchange	daily	Handysize Carrier
Baltic Supramax Index	BSI	-	Baitic Exchange	daily	Supramax Carrier
Baltic Freight Index	BFI	-	Baitic Exchange	daily	Integrated for Dry Bulk
Atlantic Capesize Index	ACI	-	SSY	daily	Capesize Carrier
Pacific Capesize Index	PCI	-	SSY	daily	Capesize Carrier
Clarkson Average Bulk Earning	CABE	USD /day	Clarkson Research Service Ltd.	daily	Integrated for Dry Bulk
ICAP Supramax Index	ISI	-	ICAP	daily	Supramax Carrier
ICAP Handymax Index	IHI	-	ICAP	daily	Hangdymax Carrier
China Import Dry Bulk Freight Index	CIBFI	-	SSE	daily	Capsize & Panamax Carrier
China Coastal Bulk Freight Index	CBFI	-	SSE	daily	Coastal Bulk Carrier
China Coastal Bulk (Coal) Freight Index	CBCFI	-	SSE	daily	Coastal Bulk Carrier

BFI started with 1000 point on Jan. 4 1985, and ceased to exist with 1339 point on Oct. 29, 1999 as the most important one in dry bulk freight market before BDI appeared. BDI is an integrated index which combines voyage freight rate and time charter rate of several typical vessel types. If combining BFI and BDI, Fig. 2-3 shows the change of dry bulk freight since 1985.

Fig. 3-3 The BFI and the BDI curve (Jan.1985-Mar.2016)[31]

[31] Data source: Shipping Intelligence Network (https://sin.clarksons.net/Timeseries)

Unlike BDI, the aim of which Clarkson developed the Calrksons Average Bulk Earning (CBAE) is to support his brokers to matchmaking the charter contract and not to make the shipping financial derivatives. So the unit of CABE is USD per day and volume is almost equal to real freight rate. Fig.3-4 gives the curve of CABE from Jan.19,1990 to Oct. 2013.

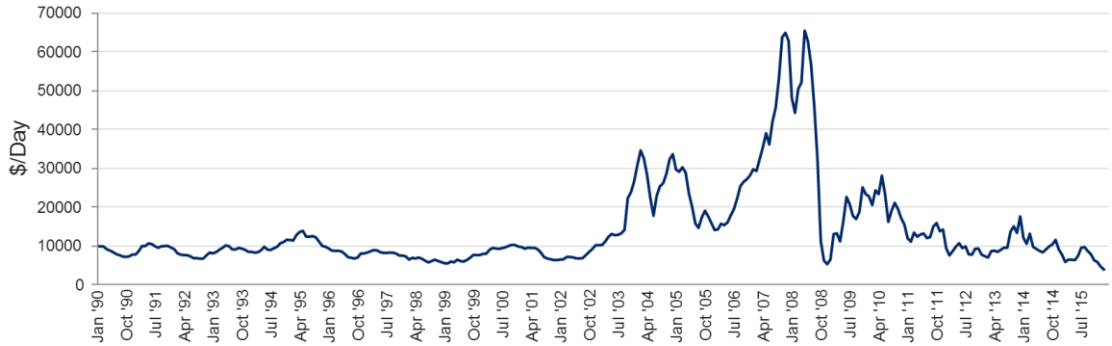


Fig. 3-4 The CBAE curve (Jan. 1990-Dec. 2015)[32]

Shanghai Shipping Exchange (SEE) also issues 3 dry bulk freight indices but only one is about import route and other two is about China coast transport. Although China is the biggest iron ore import country in the world, but most of its members are domestic enterprises, SSE just has a few useful data to issue strong dry bulk freight indices.

⑶Indices in container liner market

Compared with the tanker freight market and the dry bulk freight market, the container liner market is younger as it started in 1960s. Meanwhile, the business model of container liner market is very different from tanker and dry bulk markets. In the container liner market, carriers usually own the container fleets in which some vessels are owned by themselves and some are leased from other shipowners. The voyage chartering seldom happens. Time charter party is normal. Daily work becomes booking from chartering. Freight Forwarder instead of broker is the agent between carrier and shipper.

J. E. Davies (1986) gave the research result that the liner market is a monopoly market. His conclusion is proved continually by more and more events in last 30 years. From Sealand (the biggest liner in 1970s) to Maersk Line (the biggest liner in beginning of 21st Century), from liner conferences (1980s) to liner transport alliance (2010s), concentration rate of container market is more and more high. Therefore, the freight fee in the liner market used to be determined by the oligarchs, not by “the invisible hand”.

Fig. 3-5 The CTRI curve (Jan. 1993 –Oct. 2013)[33]

[32] Data source: Shipping Intelligence Network (https://sin.clarksons.net/Timeseries)
[33] Data source: Shipping Intelligence Network (https://sin.clarksons.net/Timeseries)

A different market system makes a different freight indices system. Most of producers of traditional maritime transport freight indices have not created new suitable system for container liner market. By understanding of the container liner market, also limited by the data source, CRSL just issues its container time charter index (CTRI) daily. Fig.3-5 shows the change of CTRI from Jan.1993 to Dec. 2015. By CTRI, CRSL issues Clarkson Average Container Earning (CACE). The unit of CACE is USD per day like CABE and CATE.

The new inventor, Shanghai Shipping Exchange was born on Nov.28, 1996. To change the history that China has no maritime transport indices, SSE set up the regulation named "freight report system" which orders 18 liner companies who have business in China report their liner freights to SSE. This "freight report system" supports SSE to issue China Export Container Freight Index (CCFI). First CCFI was issued on April 13 1998. The origin date of CCFI is Jan. 1, 1998. The origin point is 1000. Fig.3-6 gives the curve of CCFI from Mar. 2003 to Nov. 2013. CCFI includes 14 sub-indices related with 14 routes which start from 10 Chinese ports like Dalian, Tianjin, Qingdao, Shanghai, Nanjing, Ningbo, Xiamen, Fuzhou, Shenzhen and Guangzhou. CCFI is issued on every working Friday.

Fig. 3-6 The CCFI curve (Mar. 2003-Feb. 2016)[34]

Having over 10 years' experience of index developing, SSE started to issue Shanghai Container Freight Index (SCFI) formally on Oct.16, 2009. SCFI includes 15 sub-indices for 15 lines and a comprehensive index. Issuing date is every working Friday same with CCFI. The origin date of SCFI is Oct. 16, 2009. The origin point is 1000. 18 liners and 18 shippers are the data suppliers of SCFI.

Fig. 3-7 The SCFI curve (Oct. 2009-Jan. 2016)[35]

[34] Data source: http://www.sse.net.cn/index/ccfinew.jsp
[35] Data source: http://www.sse.net.cn/index/scfinew.jsp

3.2 Analysis for methodology of maritime transport indices

As section 3.1 shows, there are many indices in maritime transport market. Every index has its data source and algorithm. This section will give the methodologies of earning and freight indices by showing some typical algorithm. Function of finance indices in maritime transport market is quite various. The methodology of finance indices also is too confused for the aim of this paper to research.

3.2.1 Standardization for indices issue

Standardization for indices includes 4 parts: type of vessel, currency, contract and algorithm. This is the key factor when indices are compiled. It is also the infrastructure of the big data era.

⑴Type of vessel

There are so many kinds of vessels in the maritime transport market that could not be divided into several standard categories. But brokers make so many efforts to set up the vessel classification system like table 3-4. These terms are used widely now in maritime transport market.

Tab. 3-4 The vessel classification system for tanker and bulk carrier[36]

Type of vessel	Terms	Standard
Oil Tanker	ULCC, double hull	≥350,000DWT
	ULCC, single hull	≥320,000DWT
	VLCC, double hull	200,000-349,999DWT
	VLCC, single hull	200,000-319,999DWT
	Suezmax crude tanker	125,000-199,999DWT
	Aframax crude tanker	80,000-124,999DWT, moulded breadth>32.31m
	Panamax crude tanker	60,000-79,999DWT, moulded breadth<32.31m
	Handysize	10,000-59,999DWT
Bulk Carrier	VLOC	≥200,000DWT
	Large capsize	≥150,000DWT
	Small capsize	80,000-149,999DWT, moulded breadth>32.31m
	Panamax	55,000-84,999DWT moulded breadth<32.31m
	Handymax	35,000-54,999DWT
	Handysize	10,000-34,999DWT
Container Vessel	Post-Panamax container ship	moulded breadth>32.31m
	Panamax container ship	moulded breadth<32.31m

⑵Currency

Global maritime transport market includes two parts: international maritime transport and

[36] Data source: HIS Fairplay

domestic maritime transport.

Before 1970s, UK pound was the main currency in international maritime transport market. But now, US dollar absolutely is used as international settlement tool. Not only freight rate, but also other payments for fuel, salary, terminal charge, etc., every payment use US dollar. To reduce the influence from destabilization of currency exchange rate, brokers guide shippers and carriers use US dollar as settlement currency in their charter parties. This provides an excellent environment for issuing maritime transport indices.

But in domestic maritime transport market, the situation is quite different. Freight, salary, fuel and other cost, all of settlements use their own currencies in most countries. This is the main reason for the phenomenon that no any domestic maritime transport information could be absorbed into current maritime transport indices. Therefore, no any current maritime transport indices can reflect the domestic shipping market situation.

⑶Standard contract

The product of transportation is service. Standard contract is an important form of service standardization. Maritime transport contract used to be combined by two parts: charter party and bill of lading. For bill of lading, every carrier knows the Hague Rules, the Visby Rule, Hamburger Rule and Rotterdam Rule. Even though, some international organizations still give their standard forms for bill of lading like that list in table 3-5 because of the different cargo and route characters.

Same with bill of lading, there are many standard forms for voyage charter party and time charter party that list in table 3-5. They are made by brokers, consult companies and mercantile exchange for different cargo and routes. Gencon 94 is the most popular voyage charter party and NYPE 93 is the most popular time charter party.

Tab. 3-5 Standard contract of maritime transport[37]

Voyage Charter	Time Charter	Bill of Lading
Gencon 94	Baltime 1939 (revised 2001)	Bimchemvoybill 2008
Graincon	Bimchemtime 2005	Cementvoybill 2006
Heavycon 2007	Boxtime 2004	Coalorevoybill
Heavyliftvoy	BPTime 3	Combiconbill
Hydrocharter	Gastime	Congenbill 2007
Nipponcoal	Gentime	Grainconbill
Nipponore	NYPE 93	Norgrain Bill
Norgrain 89	Supplytime 2005	Genwaybill
Worldfood 99	WINDTIME	Yarawaybill

A voyage charter party usually includes 26 clauses that can be divided into two parts: substantive clause and procedural provisions. Vessel name, port of loading and discharge, freight rate and payment, demurrage and laytime are important terms in substantive clause.

A time charter party usually includes 37 clauses that also can be divided into two parts:

[37] Data source: https://www.bimco.org/Products/idea_2/Available_contracts.aspx

substantive clause and procedural provisions. Vessel name, period of charter, hire, excluded cargo, except countries and fuel specification are important terms in substantive clause.

⑷ Algorithm

Only based on the standard type of vessel, common currency and charter party, the algorithm for indices of maritime transport market could be executed.

The algorithm is as follows:

①Collecting charter parties as much as possible.

②Dividing the charter parties into two parts: time charter and voyage charter.

③Dividing the charter parties into several parts according to the deadweight of vessel.

④Getting the hires and changing them into standard hires if time charter party, getting the freight rate and changing them into standard hires if voyage charter party.

⑤Putting the standard hire data into the given index function according to the standard vessel type.

⑥Getting the indices of various standard types of vessel.

⑦Getting the weight for every standard type of vessel.

⑧Getting the comprehensive index by weighting method.

3.2.2 Earning index

Earning indices focus on the daily income of ship owners on different type of vessel. They are used to be issued by broker organizations like Clarkson, SSY, HR, etc. Every earning index has its given algorithm. As WS is a recognized global maritime transportation index, its algorithm will be showed as a case.

WS is an index system which focus on global tanker market. There are two operation models in international tanker market: time charter and voyage charter. Comparing standard voyage charter party and time charter party, there are several important different points related with ship-owner's earning (see table 3-6).

Tab. 3-6 Characters of VC & TC

Item	Voyage Charter	Time Charter
Time	voyage time, not fixed	contract time, fixed
Route	fixed	area limited
Revenue of shipowner	freight rate	hire
Cost of shipowner	crew salary, fuel, terminal charge	crew salary

Therefore the key technology is the calculation method which change the freight rate of voyage charter into the equivalent daily hire. Regardless of the voyage performed, the ship-owner will "theoretically" earn the same daily amount or daily hire (measured in USD/Day) after voyage costs are deducted from voyage revenue (see formula 3-1).

$$H_{ed} = \frac{R_v - C_v}{t_v} \tag{3-1}$$

In formula 3-1,

H_{ed} —The equivalent daily hire, USD/day

R_v —The freight payment made to the tanker owner in USD based on the calculation of the Worldscale published rate (USD/MT) times cargo quantity (MT), USD

C_v —The expenses incurred by the tanker owner in meeting the obligation to load, transport, and discharge charterers cargo including: port costs, fuel costs, canal charges, USD

t_v —The elapsed time in days for the vessel to carry out the laden transit and the ballast transit back to the load port, day

To let formula 3-1 work, some assumptions are necessary:

⑴Standard vessel

The specific conditions of standard vessel are shown in the table 3-7.

Tab. 3-7 The specific conditions of standard vessel

Item	Condition
Total capacity	75,000 MT
Average service speed	14.5 knots
In-transit bunker consumption	55 MT/Day
Other bunker consumption	100 MT/Voyage
Bunker grade	380 cst
Fixed hire element	US$ 12,000/Day
Port time	4 days 1:1

⑵Other Assumptions

①Bunker costs –Currently calculated as the average worldwide bunker price for 380 cst fuel oil during the October 1, 2006 through September 30, 2007.

②Port costs –As assessed by Worldscale associations based on information available to them up to the end of September 2007.

③Canal transit time –24 hours for Panama Canal transit; 30 hours for Suez Canal transit.

By formula 3-1, voyage charter rate become equivalent daily hire. Then the data from voyage charter and time charter can be processed by weighting method together.

3.2.3 Freight index

Freight indices focus on the freight rate lever of different types of vessel and different routes. They are used to be issued by shipping exchange, merchandize exchange or consultant companies. Every index organizer gives its index a special algorithm. Actually, their principle is same. As SCFI is issued by Shanghai Shipping Exchange which locates in Shanghai, China most important economic metropolis, the algorithm of SCFI will be introduced as follow.

SCFI includes 15 sub-indices for 15 routes and a comprehensive index. The port of loading is Shanghai for all 15routes. Ports of discharge are Europe, the Mediterranean, West US, East US, the Persian Gulf, Australia, West Africa, South Africa, South America, Tokyo and Yokohama,

Osaka and Kobe, South Korea, Southeast Asia, Taiwan and Hong Kong.

A freight rate for container ocean transport includes two parts: spot basic price for per TEU or per FEU and several surcharge like BAF, CAF, PCS and canal charges etc.

Freight currency is US dollar.

Type of container is GP container only for general cargo.

⑴Route index

The route indices of SCFI are calculated by simple arithmetic average method. The equation for route index is as in formula 3-2.

$$I_i = \frac{1000}{n_i} \sum_{j=1}^{n_i} \frac{F_{ij}}{F_{ij0}} \tag{3-2}$$

In formula 3-2,

i —number of the route,

j —number of rate providers on i route,

I_i —the index value of the i route

F_{ij} —the freight spot rate of the i route provided by j company, USD/TEU

F_{ij0} —the freight origin rate of the i route provided by j company, USD/TEU

n_i —the freight provider amount on i route,

The origin date is Oct.16, 2009.

⑵The rule of selection for n

To avoid oligarch liner to manipulate the index, it is necessary to add more provider in higher weight route. So selection for n is related to route weight. The rule is listed in table 3-8.

Tab. 3-8 The rule of selection for n

Route Weight	n
≤5%	≥5
5%—10%	≥6
10%—15%	≥7
≥15%	≥8

⑶Comprehensive index

Comprehensive index is calculated using the weighted average method. The equation for comprehensive index is as in formula 3-3.

$$I = \sum_{i=1}^{m} w_i I_i \tag{3-3}$$

In formula 3-3,

i —number of the route,

m —total amount of route be calculated,

w_i —weight of i route.

After using formula 3-2 and formula 3-3, SCFI can be calculated.

3.3 The indices framework design for the global maritime transport market

As shown in section 3.2, there are many index products in maritime transport market now. But they are developed by different organizations for different purposes. In this section, we try to draw the index framework for the global maritime transport market. Based on this framework, we can understand what kinds of index are needed and the suitable methodology to develop new index for different roles like investors, cargo owner, ship owner, chartering and consultancy etc. in the global maritime transport market.

3.3.1 Review for existing indices in the global maritime transport market

After researching on the present indices in maritime transport markets, three kinds of indices can be concluded: earning index, freight index and finance index. Their character can be listed in table 3-9.

Tab.3-9 The character of Maritime Transport Indices

Type of Index	Issue Date	Dimension	Producer	Function
Earning	working daily	USD/day	Broker	chartering contract
Freight	working daily	No	Exchange	FFA
Finance	weekly or monthly	No	Consultant	Investor

Main producers and types of maritime transport indices can be listed in table 3-10.

Tab. 3-10 Main producers and types of maritime transport indices

Producer		BE	WS	CRSL	Drewry	HR	ICAP	SSY	LL	BLP	SSE
Market	Index										
Tanker	Earning			*		*		*			
	Freight	*	*						*		*
	Finance				*		*		*	*	
Dry Bulk	Earning			*		*		*			
	Freight	*							*		*
	Finance				*		*		*	*	
Container Liner	Earning			*		*		*			
	Freight										*
	Finance				*		*		*	*	

Based on the research in this chapter above, some conclusion can be drawn:

⑴ All of existing indices are created according to the business demand of the producers. There is no academic research on the framework of whole indices framework of global maritime transport market.

⑵Most productions of maritime transport indices only focus on freight rate or market

earning. There is no any index focusing on the prosperity situation of global maritime transport market even sub-market.

⑶Most productions of maritime transport indices only focus on the specialized market like bulk market or tanker market. There is no any index focusing on the whole maritime transport market in the world.

⑷Also many organizations developed a plenty of indices for maritime transport market, but there are still shortages for the freight rate index or earning index in many branch markets like ro-ro market, LNG market and MPP market, etc.. In some markets like container liner market, there are only some local indices like CCFI and SCFI. The global freight index is also needed in the container liner market.

Generally, although the BDI is a very well-known index of global maritime transport market, but it just describes the freight rate situation of global bulk waterborne transport market. Market needs some indices which can show the real situation of whole global maritime transport market.

Data source is the key point for issuing the index product. For tramp market, brokers are the data source because they link the carriers and the shippers and help them reach the agreements. So brokers know detail most of the time charter parties and the voyage charter parties. By these data, the freight index for bulk market and tanker market can be issued. For container liner market, the freights of each route are determined by various liner companies. According to the opinion of Professor Martin Stopford, it is not suitable to have the freight index in container liner market if the freight data are from liner companies because it is an oligopoly market.

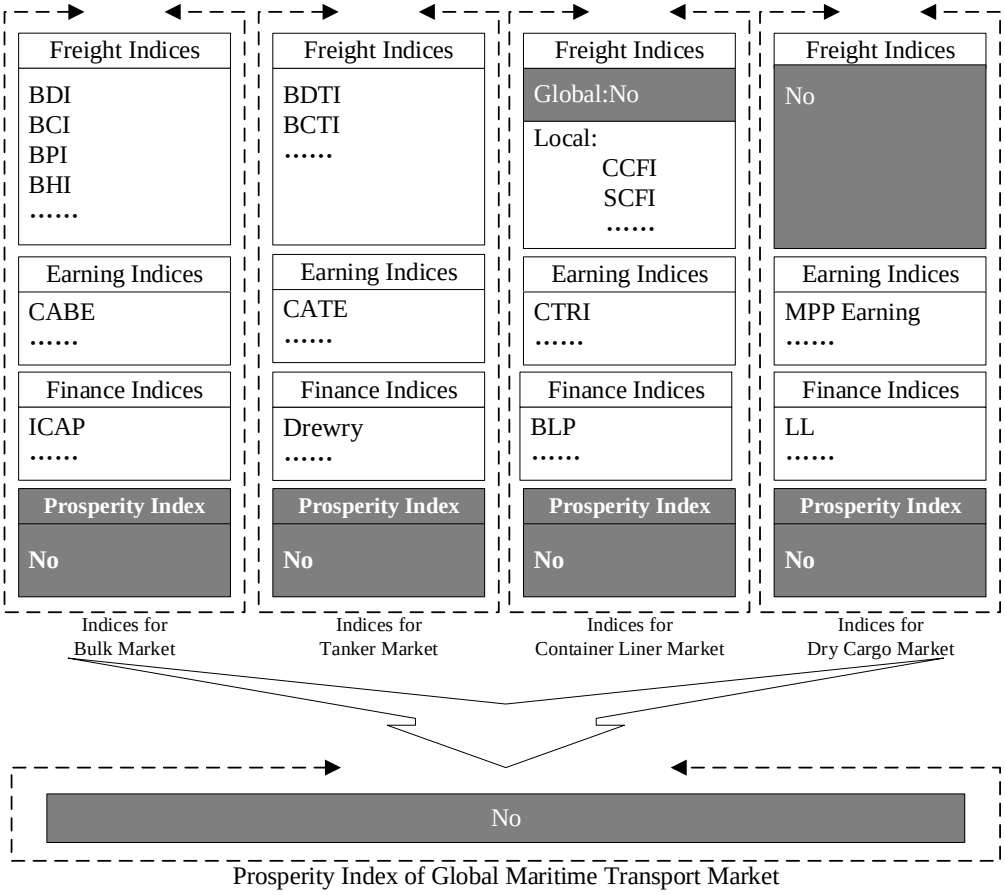


Fig. 3-8 Indices framework of global maritime transport market

3.3.2 Indices framework design for the global maritime transport market

The global maritime transport market is a typical cycle market. Cycle analysis always is a hot topic for the experts and scholars in this field. The investors who are concerned with the maritime transport market desire more suitable indices which can support them to make more correct decisions. As the limitation of the index products, some freight index like BDI and BDTI is used to be a substitute.

Based on the research above, following the structure of the global maritime transport market that UNCTAD gave in Fig.2-1, the indices framework of the global maritime transport market can be designed as in the Fig. 3-8 shown. The indices with white background already exist. The indices with grey background are to be developed.

In this framework in Fig.3-8, there are four kinds of indices in the global maritime transport market for four main branches market: freight index, earning index, finance index and prosperity index. Subjected to the limitations of the data source, there is not the freight index of dry cargo market, there are several local freight indices for container liner market, there are a lot of freight indices for tanker market and dry bulk market. The table 3-11 shows the possible users of every maritime transport index product.

Tab. 3-11 Users of maritime transport index products

Type	Market	Sample	User
Freight index	Dry Bulk	BDI	Bulk Carrier, Trader, Broker,Investor
	Tanker	BDTI、BCTI	Tanker Company, Oil Company, Broker, Investor
	Liner	No	Liner Company, Manufacturer, Forwarder, 3PL, Investor
	Dry Cargo	No	Other Shipping Company, Manufacturer, Forfarder, Investor
	Total	No	All of above
Earning Index	Dry Bulk	CABE	Bulk Carrier, Trader, Broker,Investor
	Tanker	CATE	Tanker Company, Oil Company, Broker, Investor
	Liner	CTRI	Liner Company, Manufacturer, Broker, Investor
	Dry Cargo	CALCE	Other Shipping Company, Broker, Investor
	Total	Clarksea	All of above
Finance Index	Dry Bulk	BLP, LL	Bulk Carrier, Trader, Investor
	Tanker	Drewry	Tanker Company, Oil Company, Investor
	Liner	ICAP	Liner Company, Manufacturer, Investor
	Dry Cargo	LL, Drewry	Other Shipping Company, Manufacturer, Investor
	Total	No	All of above,Large integrated shipping company, Investor
Prosperity Index	Dry Bulk	No	Bulk Carrier, Trader, Investor
	Tanker	No	Tanker Company, Oil Company, Investor
	Liner	No	Liner Company, Manufacturer, Investor
	Dry Cargo	No	Other Shipping Company, Manufacturer, Investor
	Total	No	All of above,Large integrated shipping company, Investor

Although many index products existed in the global maritime transport market, there are still some new demands which appeared with the development of the market. For example, RWL, a scientific research center whose headquarter is located in Essen, Germany, issued its Container Throughput Index (CTI) since 2008. The CTI aims at providing timely information on short term trends in global trade. RWI thought the global container throughput and international trade can be expected to be highly correlated38. Only BDI cannot give the correct information for global trade

[38] Data source: http://en.rwi-essen.de/presse/mitteilung/272/

and maritime transport market.

Based on the indices framework of global maritime transport market shown in Fig. 3-9, Chapter 4 will research the necessity of the Prosperity Index of Global Maritime Transport Market, Chapter 5 will research the calculation methodology of the PIGMT. Chapter 6 will research the calculation methodology of the Daily Container Freight Index.

Chapter 4 Research on Prosperity Indices

To development the Prosperity Index of Global Maritime transport Market (PIGMT) in the index framework as in Fig. 3-8, it is necessary to know what the prosperity index is and the methodology of the prosperity. The aim of this chapter is to find the feasibility of application of prosperity indices in the global maritime transport market. First, the history of prosperity indices will be introduced. Then the research will focus on the success case of prosperity indices in national economy and some industries. At last, the methodology of prosperity indices will be discussed in detail.

4.1 Introduction of prosperity indices

Prosperity indices are also called business cycle indicators or economic cycles monitoring indicators. Although these indicators have different name, their main functions are almost same. They are to show the economic fluctuation of national economy or industry economy. In 1973, IEI was developed to make comparison of the competitiveness or the prosperity lever for a numbers of countries. After the global financial crisis in 2008, the Legatum Institute makes the Legatum Prosperity Index™ to give a holistic view of prosperity for most of countries in the world.

4.1.1 Theory of business cycles

After the Napoleonic wars (1815), there were frequent crises in Europe and America in the 19th and first half of the 20th century, specifically the period 1815–1939. Specially, the Great Depression of 1929–39 led into World War II.

Jean Charles Léonard de Sismondi (1819) gave first systematic exposition of periodic economic crises, in opposition to the existing theory of economic equilibrium. Clement Juglar (1860) first identified economic cycles 7 to 11 years long, although he cautiously did not claim any rigid regularity. Later, Joseph Schumpeter described four stages of business cycles: ⑴ expansion (increase in production and prices, low interest-rates), ⑵crisis (stock exchanges crash and multiple bankruptcies of firms occur), ⑶recession (drops in prices and in output, high interest-rates), ⑷recovery (stocks recover because of the fall in prices and incomes).

Business cycles after World War II were generally more restrained than the earlier business cycles. This was particularly true during the Golden Age of Capitalism (1945/50–1970s) under the guidance of Keynes (1883-1946), and the period 1945–2008 did not experience a global downturn. Economic stabilization policy using fiscal and monetary policy appeared to have dampened the worst excesses of business cycles, and automatic stabilization due to the aspects of the government's budget also helped mitigate the cycle even without conscious action by policymakers.

In this period, the business cycle was twice declared dead. The first declaration was in the late 1960s, when the Phillips curve was seen as being able to steer the economy. However, this was followed by stagflation in the 1970s, which discredited the theory. The second declaration was in the early 2000s, following the stability and growth in the 1980s and 1990s in what came to be known as The Great Moderation.

The explanation of fluctuations in aggregate economic activity is one of the primary concerns of macroeconomics. The main framework for explaining such fluctuations is Keynesian

economics. According to Keynesian economics, fluctuations in aggregate demand cause the economy to come to short run equilibrium at levels that are different from the full employment rate of output. These fluctuations express themselves as the observed business cycles. Keynesian models do not necessarily imply periodic business cycles. However, simple Keynesian models involving the interaction of the Keynesian multiplier and accelerator give rise to cyclical responses to initial shocks. Paul Samuelson's "oscillator model" is supposed to account for business cycles thanks to the multiplier and the accelerator. The amplitude of the variations in economic output depends on the level of the investment, for investment determines the level of aggregate output (multiplier), and is determined by aggregate demand (accelerator).

Arthur F. Burns and Wesley C. Mitchell (1946) provided the present standard definition of business cycles. Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises. A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions and revivals, which merge, into the expansion phase of the next cycle. In duration, business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar characteristics with amplitudes approximating their own.

Even at this late date, economists are much better at analyzing the optimal response of a single economic agent to changing conditions than they are at analyzing the equilibria that will result when diverse agents interact. This unfortunate truth helps to explain why macroeconomics has found the task of controlling, predicting, or even explaining economic fluctuations so difficult. Improvement in the track recorder of macroeconomics will require the development of theories that can explain why exchange sometimes works well and other times breaks down. Nothing could be more counterproductive in this regard than a lengthy professional detour into the analysis of stochastic Robinson Crusoes.

4.1.2 International economic indicator system

Founded in 1920, the National Bureau of Economic Research is a private, nonprofit, nonpartisan research organization dedicated to promoting a greater understanding of how the economy works. It is committed to undertaking and disseminating unbiased economic research in a scientific manner, and without policy recommendations, among public policymakers, business professionals, and the academic community. Now the NBER is the nation's leading nonprofit economic research organization. Twenty-four Nobel Prize winners in Economics and thirteen past chairs of the President's Council of Economic Advisers have been researchers at the NBER.

To describe the business cycle exactly and iconically, NBER (1930s) developed a system of leading, coincident, and lagging economic indicators. Leading indicators consistently turn before the economy does. Coincident indicators turn in step with the economy and track the business cycle's progress. Lagging indicators turn after the economy turns, and play a confirmatory role. For decades, the index system and the algorithm are in continuous improvement. With these indicators, NBER found 33 cycles from middle of 18th Century to 2009. There were 16 cycles during 1854-1919, 6 cycles during 1919-1945 and 11 cycles after World War II. Now this indicator system has been widely used in not only the United States but also European countries, China, Japan, Canada, etc. to appraise the state of the business cycle. Because of differences in content or methodology, however, these independent efforts do not provide comparable materials.

Table 4-1 gives the business cycle expansions and contraction for United States.

Tab. 4-1 US business cycle expansions and contractions[39]

Peak	Trough	Contraction	Expansion	Cycle	
		Peak to through	Previous trough to this peak	Trough from previous trough	Peak from previous peak
	Dec. 1854	--	--	--	--
Jun. 1857	Dec. 1858	18	30	48	--
Oct. 1860	Jun. 1861	8	22	30	40
Apr. 1865	Dec. 1867	32	46	78	54
Jun. 1869	Dec.1870	18	18	36	50
Oct. 1873	Mar. 1879	65	34	99	52
Mar. 1882	May 1885	38	36	74	101
Mar. 1887	Apr. 1888	13	22	35	60
Jul. 1890	May 1891	10	27	37	40
Jan. 1893	Jun. 1894	17	20	37	30
Dec. 1895	Jun. 1897	18	18	36	35
Jun. 1899	Dec. 1900	18	24	42	42
Sep. 1902	Aug. 1904	23	21	44	39
May-07	Jun. 1908	13	33	46	56
Jan. 1910	Jan. 1912	24	19	43	32
Jan. 1913	Dec. 1914	23	12	35	36
Aug. 1918	Mar. 1919	7	44	51	67
Jan. 1920	Jul. 1921	18	10	28	17
May-23	Jul. 1924	14	22	36	40
Oct. 1926	Nov. 1927	13	27	40	41
Aug. 1929	Mar. 1933	43	21	64	34
May-37	Jun. 1938	13	50	63	93
Feb. 1945	Oct. 1945	8	80	88	93
Nov. 1948	Oct. 1949	11	37	48	45
Jul. 1953	May-54	10	45	55	56
Aug. 1957	Apr. 1958	8	39	47	49
Apr. 1960	Feb. 1961	10	24	34	32
Dec. 1969	Nov. 1970	11	106	117	116
Nov. 1973	Mar. 1975	16	36	52	47
Jan. 1980	Jul. 1980	6	58	64	74
Jul. 1981	Nov. 1982	16	12	28	18
Jul. 1990	Mar. 1991	8	92	100	108
Mar. 2001	Nov. 2001	8	120	128	128
Dec. 2007	Jun. 2009	18	73	91	81

Note: Month numbers start in January 1800

[39] Data Source: NBER. US Business Cycle Expansions and Contractions. http://www.nber.org/cycles/cyclesmain.html

In 1973, the NBER began to develop an international economic indicator system (IEI) that would provide comparable data, organized and analyzed in a comparable manner, for a number of industrial countries. The Center for International Business Cycle Research at Rutgers University in New Jersey has continued this work since 1979. The research has demonstrated that such a system can be helpful in tracking an international recovery or recession, in revealing factors that are holding back recovery or leading to recession, in anticipating changes in foreign trade flows, and in providing early warning of new inflationary trends. The Organization for Economic Cooperation and Development (OECD) and statistical agencies in Canada, the United Kingdom, West Germany, France, Italy, Japan, and the United States have cooperated with the NBER and with the Rutgers Center in compiling and analyzing the current data for this system of indicators. The practical results of this research program are now available for use.

⑴Functions of IEI

IEI has four functions.

First and important function of the IEI system is to detect a worldwide recession or recovery promptly. The importance of this function is underlined by the fact that international recessions—those in which many countries participate more or less simultaneously —have been more serious than localized recessions.

Second function of the indicator system is to measure the scope, severity, and unusual features of an international recession or recovery while it is in progress.

Third function is to help appraise prospects for foreign trade. For example, the leading indicators are sensitive measures of the general state of demand. The international indicator system should therefore help people anticipate changes in the flow of trade to the countries.

Fourth function is that can provide early warning signals of an acceleration or deceleration in the rate of inflation. Inflation is an international phenomenon. All countries experience it, and waves of inflation often occur at about the same time in many countries.

⑵ Leads and lags in recovery and recession

The international economic indicator system consists of groups of leading, coincident, and lagging indicators covering a wide variety of economic processes that have been found to be important in business cycles.

The leading indicators are for the most part measures of anticipations or new commitments. They have a "look-ahead" quality and are highly sensitive to changes in the economic climate as perceived in the marketplace.

The coincident indicators are comprehensive measures of economic performance: real GNP, industrial production, employment, unemployment, income, and trade. They are the measures to which everyone looks to determine whether a nation is prosperous or depressed.

The lagging indicators are more sluggish in their reactions to the economic climate, but they serve a useful purpose by smoothing out and confirming changes in trend that are first reflected in the leading and coincident indicators. Moreover, their very sluggishness can be an asset in cyclical analysis, because when they do begin to move, or when they move rapidly, they may show that excesses or imbalances in the economy are developing or subsiding. Hence the lagging indicators can (and often do) provide the earliest warnings of all, as when rapid increases in costs of production outstrip price increases and threaten profit margins, thus inhibiting new commitments

to invest, which are among the leading indicators.

⑶ Impaction for inflation

The international economic indicator system is helpful in examining the evidence, and so is the concept of the growth cycle described earlier. This distinguishes periods of rapid growth from periods of slow growth by reference to a long-run trend. Trend-adjusted data rise as long as the short-run rate of growth exceeds the long-run rate. They decline as long as the short-run rate is less than the long-run rate. The peaks and troughs in trend-adjusted data, therefore, delineate periods of rapid and slow growth relative to the trend rate.

4.1.3 The Legatum Prosperity Index

The indicators like GNP, GDP and Personal Income give only the wealth of country or family. Most people understand intuitively that 'prosperity' is not just about money, it is also about satisfaction with human lives and future prospects. Although NBER gives a system of leading, coincident, and lagging economic indicators to instead of GNP or GDP, most economists traditionally use a simple economic measure known as GDP to define prosperity. Whether measured in total for a country or on a per-capita basis, GDP is the most familiar and widely used measure of national progress. It captures the value of all goods in the economy—whether consumed by households, governments, or businesses—and as such, it is an extremely useful single measurement of a country's well-being.

In 2008 when the financial crisis happened, French president Nicolas Sarkozy created the Commission on the Measurement of Economic and Social Progress. Sarkozy believes that GDP is not a sufficient measurement of national well-being. While GDP encompasses myriad economic variables—broadly representing a nation's income and, hence, economic progress over time—it fails to capture important ingredients of prosperity, such as health, personal freedom, and security. Meanwhile some different opinion exist. Diane Coyle argues that GDP increasingly underestimates wellbeing, and therefore reports of economy's stagnation may be greatly exaggerated. There is no Great Stagnation. There is only a widening gap between the rate of economic improvement and the ability to measure that improvement.

To give a holistic view of prosperity, the Legatum Institute created the Legatum Prosperity Index™ first time in 2009. The Legatum Institute is a privately funded think-tank founded in 2007 and located in Mayfair, London. As the most famous prosperity index, The Legatum Prosperity Index™ provides the world's only global assessment of prosperity based on both income and wellbeing annually. Its purpose is to encourage policymakers, scholars, the media and the interested public to take a holistic view of prosperity and understand how it is created. Holistic prosperity extends beyond just material wealth, and includes factors such as social capital, health, opportunity, security, effective governance, human rights and liberties, and overall quality of life.

The Legatum Prosperity Index (LPI) is based on 79~90 different variables analysed across 104~142 nations around the world. Its data source includes Gallup World Poll, World Development Indicators, International Telecommunication Union, Failed States Index, Worldwide Governance Indicators, Freedom House, World Health Organization, World Values Survey, Amnesty International, Centre for Systemic Peace. The 79~90 variables are grouped into 8~9 sub-indexes, which are averaged using equal weights.

Table 4-2 gives the methodology change of the LPI.

Tab.4-2 Methodology change of the LPI

Year	Number of countries	Number of variables	Number of sub-indexes
2009	104	79	9
2010	110	90	8
2011	110	89	8
2012	142	89	8
2013	142	89	8
2014	142	89	8
2015	142	89	8

From 2011, the 8 sub-indexes are Economy, Entrepreneurship & Opportunity, Governance, Education, Health, Safety & Security, Personal Freedom, Social Capital. In 2015 annually report, not only the overall ranking and sub-index ranking but also the trends for five years (2009-2015) are given for 142 countries. Table 4-3 gives the LPI ranking samples for 10 countries (or special districts) in 2013. From table 4-3, it is easy to be found that the big difference between Japan and China is the situation of safety & security and personal freedom. But something is difficult to be understood that Hong Kong is ranking top 1 in the indicator of safety & security and Singapore is ranking top 1 in the indicator of economy.

Tab.4-3 the LPI ranking samples for 10 countries (or special districts) in 2015[40]

Ranking	Name	A	B	C	D	E	F	G	H
1	Norway	4	5	8	5	4	8	3	2
11	United States	11	11	11	9	1	33	15	11
14	Germany	5	16	16	12	6	21	17	16
17	Singapore	1	12	13	15	14	18	32	25
19	Japan	25	22	19	28	7	22	33	29
20	Hong Kong	24	10	22	53	28	1	26	27
21	Taiwan	20	21	36	22	23	6	31	22
22	France	30	19	20	26	8	31	21	53
28	South Korea	17	23	30	25	21	17	66	85
52	China	3	59	67	63	56	100	120	28
54	Brazil	43	53	62	84	53	85	41	75
58	Russia	55	42	106	29	42	91	111	50
99	India	61	94	53	92	107	114	79	129

A- Economy; B- Entrepreneurship & Opportunity; C- Governance; D- Education; E- Health; F- Safety & Security; G- Personal Freedom; H-Social Capital.

Also in 2015 report, overall prosperity year-on-year ranking (2009-2015) was listed for 142 countries and special economic districts. The ranking of some selected countries is listed in table 4-4. From the ranking list, the prosperity situation (not only GDP) of these countries can be known

[40] Data source: http://media.prosperity. com

more easily.

Tab.4-4 the LPI ranking change for 12 countries (or special districts) from 2009-2015[41]

Name	2009	2010	2011	2012	2013	2014	2015
Norway	1	1	1	1	1	1	1
United States	10	10	10	12	11	10	11
Germany	16	15	15	14	14	14	14
Singapore	17	17	16	19	18	18	17
Hong Kong	21	20	19	18	19	20	20
France	18	19	18	21	20	21	22
Japan	19	18	21	22	21	19	19
Taiwan	22	22	20	20	22	22	21
South Korea	29	27	24	27	26	25	28
Brazil	45	45	42	44	46	49	54
China	58	58	52	55	51	54	52
Russia	62	63	59	66	61	68	58
India	78	88	91	101	106	102	99

4.2 National prosperity indicators

After the NBER created the business cycle research method, more and more countries set up their national prosperity indices with different names by the methodology of the NBER. This section just gives the situations of United States, Japan and China.

4.2.1 United States

The Economics and Statistics Administration (ESA) is the official organizer who can release economic indicators in United States. There are many private institutions who produce varying economic indicators. For business cycle indicators of US, the Conference Board and the Economy Cycle Research Institute (ECRI) are the representatives of them.

⑴The Economics and Statistics Administration

ESA is an affiliate of the United States Department of Commerce (DOC). It releases 12 monthly and quarterly Principal Federal Economic Indicators collected by its constituent bureaus: the U.S. Census Bureau and the Bureau of Economic Analysis (BEA). The 12 monthly indicators are Advance Monthly Sales, Advance Report on Durable Goods, Construction Spending, Current Account Balance, Gross Domestic Product, Manufacturers' Shipments, Inventories and Orders, Manufacturing and Trade: Inventories and Sales, New Home Sales, New Residential Construction, Personal Income and Spending, U.S. Trade Balance and Wholesale Trade.

Beginning in Oct. 1961, ESA produced and published leading, coincident and lagging indices of United States in Business Condition Digest with the methodology of NBER. 35 years later, DOC thought ESA must pay more attention to the GDP in 1995. Then ESA devolved the work for leading, coincident and lagging indices of US economy on The Conference Board (TCB) since

[41] Data source: http://media.prosperity. com

1996.

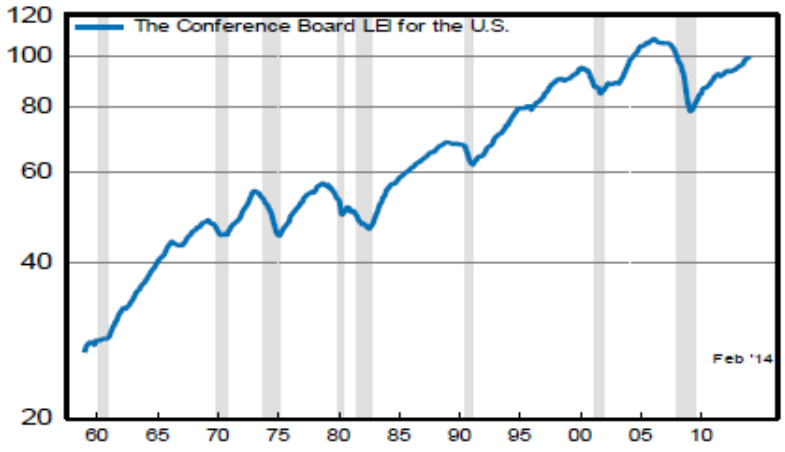
⑵The Conference Board

On May 5, 1916, in the Hotel Gramatan in Bronxville, New York, the National Industrial Conference Board became an official entity. The board changed its name to The Conference Board (TCB) in 1970. Now, TCB is a global, independent business membership and research association working in the public interest. The mission of TCB is unique: To provide the world's leading organizations with the practical knowledge they need to improve their performance and better serve society. TCB works within and across three main subject areas – Corporate Leadership; Economy & Business Environment; and Human Capital – to create a unique, enterprise-wide perspective that helps business leaders respond today, anticipate tomorrow, and make the right strategic decisions every day.

The last comprehensive revision of the leading economic index (LEI) for the United States was implemented in 1996, after TCB had assumed responsibility for the Business Cycle Indicators program and started publishing the LEI. Now, TCB has 7 groups of data products: ①Board Diversity Scenario Model, ②Business Cycles, ③Consumer Measures, ④Corporate Leadership Benchmarking, ⑤Labor Markets, ⑥Productivity & Innovation and ⑦Proxy Voting Data. There are not only The Conference Board Leading Economic Index® (LEI), The Conference Board Coincident Economic Index® (CEI) and The Conference Board Lagging Economic Index® (LAG) for the U.S., but also these indices for Australia, Brazil, China, Euro-area, France, Germany, India, Japan, South Korea, Mexico, Spain an d U.K. in the Business Cycles group.

The U.S. Leading Economic Index includes 10 components: ①Average weekly hours, manufacturing; ②Average weekly initial claims for unemployment insurance; ③Manufacturers' new orders, consumer goods and materials; ④ISM® new orders index; ⑤Manufacturers' new orders, nondefense capital goods excl. aircraft; ⑥Building permits, new private housing units; ⑦Stock prices, 500 common stocks; ⑧Leading Credit Index™; ⑨Interest rate spread, 10-year Treasury bonds less federal funds; ⑩Avg. consumer expectations for business conditions.

The U.S. Coincident Economic Index includes 4 components: ①Employees on nonagricultural payrolls; ②Personal income less transfer payments; ③Industrial production and ④Manufacturing and trade sales.



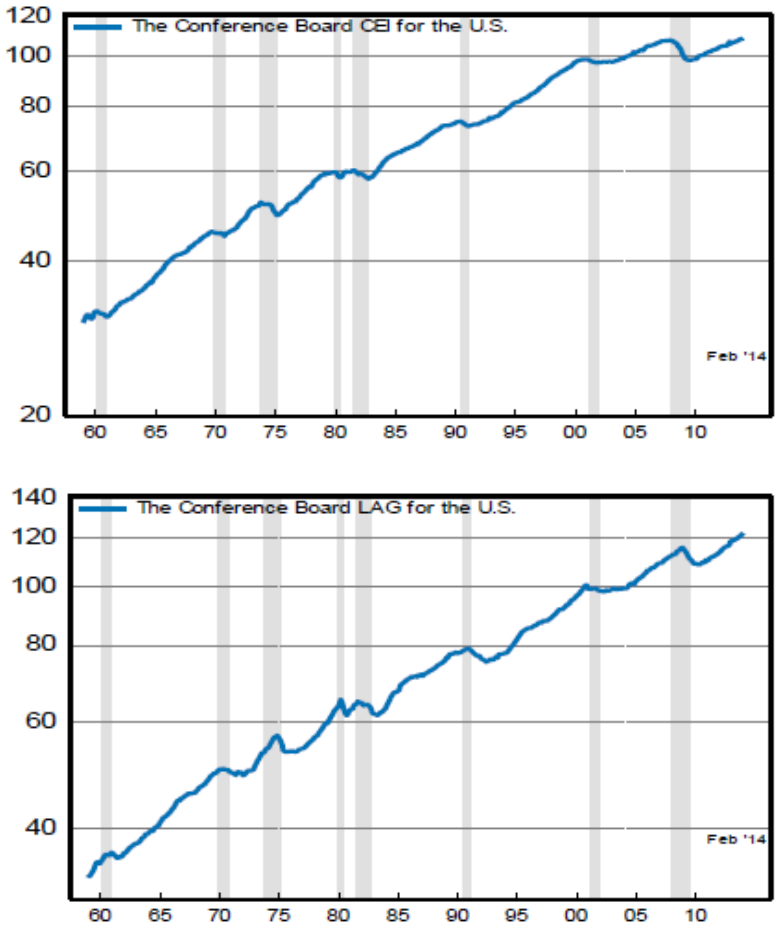


Fig.4-1 U.S. Composite economic indexes (2004=100)[42]

The U.S. Lagging Economic Index includes 7 components: ① Average duration of unemployment; ②Inventories to sales ratio, manufacturing and trade; ③Labor cost per unit of output, manufacturing; ④Average prime rate; ⑤Commercial and industrial loans; ⑥Consumer installment credit to personal income ratio and ⑦Consumer price index for services.

The U.S. Composite Economic Indexes are shown in Fig. 4-1.

⑶The Economic Cycle Research Institute

The Economic Cycle Research Institute (ECRI) is an independent institute dedicated to economic cycle research, with a mission to "advance the tradition of business cycle research established at the National Bureau of Economic Research (NBER) and Center for International Business Cycle Research (CIBCR)." In 1996, Geoffrey H. Moore, who received the American Economic Association's Distinguished Fellow Award, with his protégés, Lakshman Achuthan and Anirvan Banerji. Dr. Moore had been researching the problems of predicting the economic cycle since 1950. In 1958 he developed the composite method which would eventually become the LEI. In March 2000, Moore died at the age of 86, after a 62-year career in business cycle research.

Over decades, ECRI has developed more than 100 proprietary indexes covering 21 countries, including multi-country groupings. Fig.4-2 gives the Indexes system shown on the webpage of

[42] Data source: https://www.conference-board.org/about/index.cfm?id=1980

ECRI.

These cases above show that US economists have made great achievements in the field of business cycle base on huge numbers of data analysis. America economists made the greatest contribution in this field. As the limitation of paper pages, the name of U.S. economists and their research results cannot be listed one by one here.

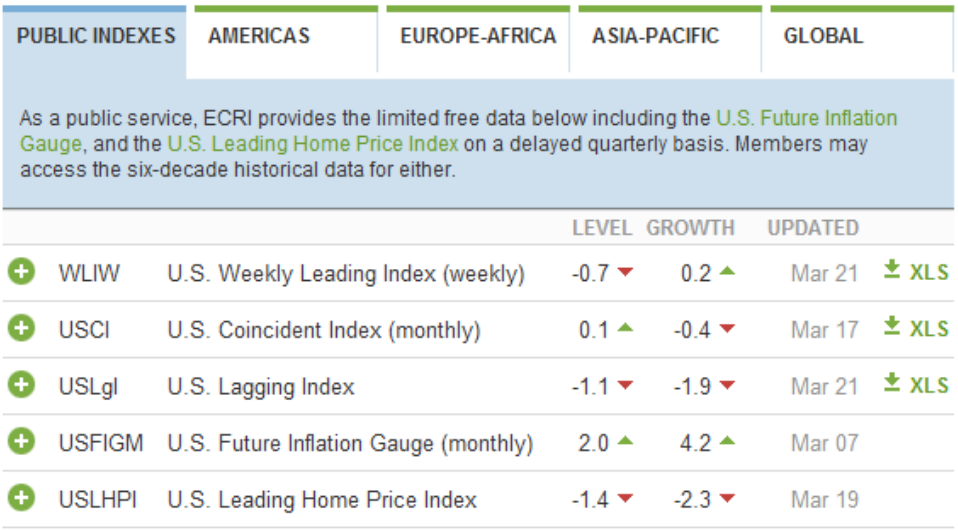


Fig.4-2 The indexes system showed on the webpage of ECRI[43]

4.2.2 Japan

Following American faculties, Japanese economists started the study on the business cycle after World War II. They organized some official institutions and independent institutes. Their research results published on books and journals always attract worldwide attention.

⑴Official Institution

From August 1960 to 2000, the Economic Planning Agency (EPA) produced and released the Indexes of Business Conditions. Since 2001, Economic and Social Research Institute (ESRI) is responsible for the indices.

The Economic and Social Research Institute (ESRI) introduced (2015) itself on its webpage: founded in January 2001 as part of the Cabinet Office with the expansion of the functions and scale of the Economic Planning Agency's Economic Research Institute under the reorganization of Japan's central government ministries and agencies, known as the "forum for knowledge" for the Cabinet, the Cabinet Office is in charge of key administrative issues. As the Cabinet Office's think tank, the ESRI links theory with policy.[44]

The Indexes of Business Conditions also includes leading, coincident and lagging indicators. EPA and ESRI made important improvement for the indicator system at least 10 times. Recent indicator system is as follows:

①Leading indicators

[43] Data source: https://www.businesscycle.com/ecri-reports-indexes/all-indexes#
[44] Data source: http://esri.go.jp/en/esri/menu-e.html

There are 11 indices in leading indicator group.

L1: Index of Producer's Inventory Ratio of Finished Goods (Final Demand Goods)(Inverted)

L2: Index of Producer's Inventory Ratio of Finished Goods (Producer Goods For Mining and Manufacturing)(Inverted)

L3: New Job offers (Excluding New School Graduates)

L4: New Orders for Machinery at Constant Prices (Excluding Volatile Orders)

L5: Total Floor Area of New Housing Construction Started

L6: Consumer Confidence Index

L7: Nikkei Commodity Price Index (42items)

L8: Interest Rate Spread

L8A: Newly Issued Government Bonds Yield (10 Years)

L8B: Tokyo Interbank Offered Rates(3 Months)

L9: Stock Prices(TOPIX)

L10: Index of Investment Climate (Manufacturing)

L10A: Ratio of Operating Profits to Total Assets (Manufacturing)

L10B: Newly Issued Government Bonds Yield (10 Years)

L11: Sales Forecast D.I. of Small Businesses

②Coincident indicators

There are 11 indices in coincident indicator group.

C1: Index of Industrial Production (Mining and Manufacturing)

C2: Index of Producer's Shipments (Producer Goods for Mining and Manufacturing)

C3: Large Industrial Power Consumption

C4: Index of Producer's Shipment of Durable Consumer Goods

C5: Index of Non-Scheduled Worked Hours(IndustriesCovered)

C6: Index of Producer's Shipment (Investment Goods Excluding Transport Equipments)

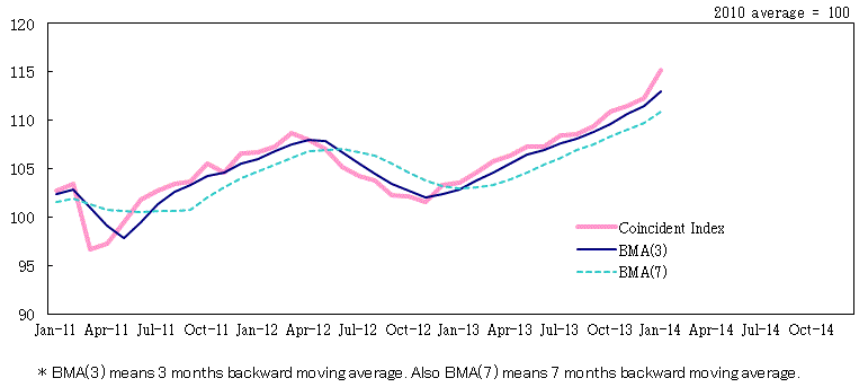
C7: Retail Sales Value(Change From Previous Year)

C8: Wholesale Sales Value(Change From Previous Year)

C9: Operating Profits (All Industries)

C10: Index of Shipment in Small and Medium Sized Enterprises

C11: Effective Job Offer Rate (Excluding New School Graduates)



＊BMA(3) means 3 months backward moving average. Also BMA(7) means 7 months backward moving average.

Fig.4-3 Coincident index graph of business condition[45]

[45] Data source: http://www.esri.go.jp/index-e.html

Fig.4-3 gives the coincident index graph of Business Condition from Jan. 2011 to Mar. 2014.

③Lagging Indicators

There are 6 indices in lagging indicator group.

LG1: Index of Tertiary Industry Activity (Business Services)

LG2: Index of Regular Workers Employment(Change From Previous Year)

LG3: Business Expenditures for New Plant and Equipment at Constant Prices (All Industries)

LG4: Living Expenditure (Workers' Households, Change From Previous Year, not including Agricultural, Forestry and Fisheries Households)

LG5: Corporation Tax Revenue

LG6: Unemployment Rate(Inverted)

⑵Independent institute

There are some independent research institutes in Japan. The Research Institute of Economy, Trade and Industry (RIETI) and Japan Center for Economic Research (JCER) are good examples.

RIETI is a policy think tank established in 2001. RIETI (2015) showed the mission on webpage: to conduct theoretical and empirical research, maximize synergies with those engaged in policymaking, and to make policy proposals based on evidence derived from such research activities. The institute set up numbers of industry database for research, encourage scholars to publish their opinion for economy.[46]

As a non-profit independent research institution established in 1963, JCER offers a variety of seminars, economic forecasts and research for Corporate Members. Fig.4-4 shows one of JCER's products: World Business Climates Index. This index gives another view for business cycle.

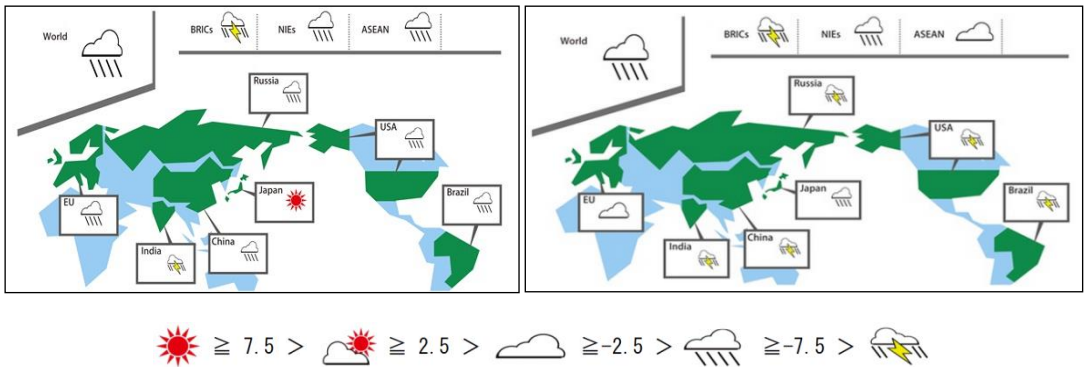


Fig.4-4 World business climates index (left: March 2014, right: May 2016)[47]

⑶Economist

Japanese economists put more and more attention to the economy development theory. The problem of economy prosperity and depression always is hot topic.

TAKATOSHI ITO (1990) constructs a theoretical model of political business cycles in the Japanese parliamentary system and tests against the postwar Japanese data predictions and hypotheses derived from the theoretical model. Nobuhiro Kiyotaki and Kenneth D. West (1996) attempt to explain the behavior of business fixed investment in Japan, with extra attention given to

[46] Data source: http://www.rieti.go.jp/en/about/about.html
[47] Data source: http://www.jcer.or.jp/eng/about/

the 1986-1994 cycle. Computing the relevant present value from data on output and the tax-adjusted cost of capital, They conclude that business investment in Japan had responded to output and the cost of capital in a sensible way. Tatsuo Yanagita (2000) described International Monetary Fund Conditionality and the Korean Economy in the Late 1990s.

Fumio Hayashia and Edward C Prescott (2002) wrote a famous paper “The 1990s in Japan: A Lost Decade”. They examined the Japanese economy in the 1990s, a decade of economic stagnation and found that the problem is not a breakdown of the financial system, but a low productivity growth rate. Growth theory, treating TFP as exogenous, accounts well for the Japanese lost decade of growth. Minoru Hayashida, Hiroyuki Ono and Takeru Terao (2007) scrutinized the model of Hayashida and Prescott found some doubt on validity of their hypothesis on Japan’s lost decade.

Tamotsu Onozaki, Tatsuo Yanagita (2003) investigated the time evolution of the market structure, employing a discrete-time, nonlinear model characterized by agents with bounded rationality and product differentiation. Simulation results showed that monopoly and oligopoly emerges out of competitive situations as the key parameter of consumer’s inertia increases.

Kobayashi Keiichiro (2006) analyzed data on the Japanese economy from the 1980s through 1990s to look into the true cause of the prolonged recession of the 1990s with "business cycle accounting (BCA)". Tamotsu Onozaki etc. (2007) provided an example in which regional business cycles may synchronize via producers’ expectations, even though there is no interregional trade, by means of a system of globally coupled, noninvertible maps. Simulation results show that the intermittent clustering process with a long chaotic transient appears repeatedly.

Satoshi Shimizutani, Yasuyuki Todo (2008) explored what factors determine the nature, extent, and location of Japanese multinationals’ R&D activities abroad. The study distinguishes between two types of overseas R&D: basic/applied research and development/design. The results provide a convincing and comprehensive explanation of the geographical distribution of overseas. Michael Artis and Toshihiro Okubo (2008) studed the intranational business cycle – that is the set of regional (prefecture) business cycles – in Japan.

Keisuke Otsu (2011) used the business cycle accounting method to show that efficiency and labor market distortions were important in accounting for the quarterly business cycle fluctuation patterns in Japan. Fiscal and monetary variables such as labor income tax, money growth, and interest rates cannot fully account for the distortions in the Japanese labor market.

Kawasaki Kentaro (2013) proposed utilizing a regional monetary unit (RMU) in monitoring exchange rates. Empirical analysis had confirmed that deviation indicators of RMUs such as the Asian Monetary Unit Deviation Indicators (AMU DI) were expected to be useful for macroeconomic surveillance. IKED Yuichi etc.(2013) analyzed the quarterly GDP time series for Australia, Canada, France, Italy, the United Kingdom, and the United States from Q2 1960 to Q1 2010 in order to obtain direct evidence for the synchronization and to clarify its origin. They found frequency entrainment and partial phase locking to be direct evidence of synchronization in international business cycles. Furthermore, they developed a coupled limit-cycle oscillator model to explain the mechanism of synchronization.

Therefore, Japanese economists make a plenty of results in macroeconomics and business cycle. Specially, their research on Japan economy is based on their huge database.

4.2.3 China

Since middle of 1980s, the research on economic cycle theory and methodology of prosperity indices has begun in China. After over 30 years, many official and independent institutions for economy research are set up. More and more economic indicators are released.

⑴Official Institution

China Economic Monitoring & Analysis Center (CEMAC) was set up in June 1999. CEMAC (2015) introduces itself like that: an affiliate of National Bureau of Statistics of China, to guide the work of the society and public opinion survey agency of national statistical organizations, to provide the public monitoring of economic and social climate information and supply statistical consulting services. Nov. 8, 2004, Goldman Sachs announced that it has entered into a cooperation agreement with the China Economic Monitoring and Analysis Center (CEMAC), to jointly develop and publish economic indicators which will provide a clearer and more comprehensive assessment of China's growing economy. The new indicators, named the CEMAC-Goldman Sachs Coincidence Indicator and the CEMAC-Goldman Sachs Leading Indicator, are compiled using the same methodology as in many developed countries and use components that are selected in line with global standards. CEMAC developed and publish itself lagging indicator. Based on these leading, coincident and lagging indicators, CEMAC further creates the early warning indicator.[48]

The sub-indicators of leading, coincident and lagging indicators are listed as follows.

①CEMAC-Goldman Sachs Leading Indicator

There are 8 indices in leading indicator group.

L1: Hang Seng Mainland 100

L2: Money supply M2

L3: Value of new projects

L4: Consumer confidence index

L5: Sales rate of product

L6: Leading indicators of real estate

L6A:Land square for real estate development

L6B:Square of new commercial housing construction

L7: Cost of carry for national debt

L8: Logistics indicators

L8A: Cargo transport volume

L8B: Cargo throughput of coastal ports

②CEMAC-Goldman Sachs Coincidence Indicator

There are 4 indices in coincident indicator group.

C1: Index of industrial production

C2: Number of employed persons in industry

C3: Social income index

C3A: National government revenue

C3B: Total profit of industry enterprises above designated size

C3C: The disposable income of residents

[48] Data source: http://www.cemac.org.cn/gywm.html

C4: Index of Social Demand

C4A: Investment in fixed assets

C4B: Social total goods retail

C4C: Total value of imports and exports (Customs data)

③Lagging indicators

There are 5 indices in lagging indicator group.

LG1:National government expenditure

LG2:Domestic loan

LG3:Household saving

LG4: Residents consumption price index

LG5:Inventory of Industrial Enterprises

With the indicator system, CEMAC set Jan. 1996 to be the initial point. They produced the data and published indicators like Fig. 4-5.

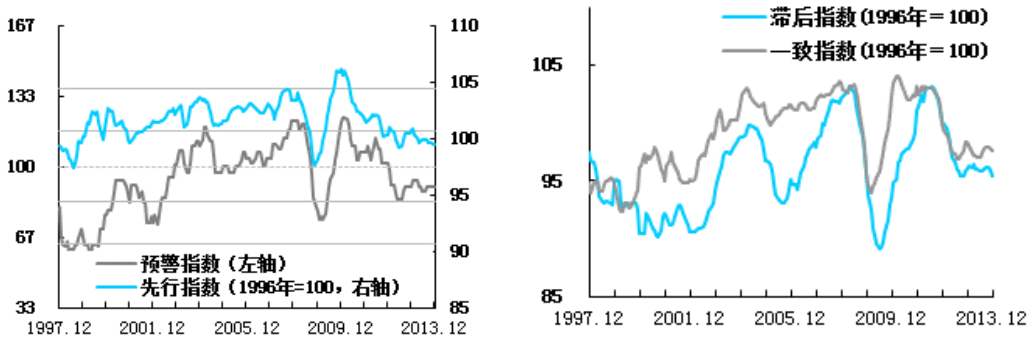


Fig.4-5 Indicators system of the CEMAC[49]

⑵Independent Institute

There are more and more independent economic research institutions in China since year 2000. Some of them are named “think tank”. State Information Center (SIC) and China Center for International Economic Exchanges (CCIEE) are good examples.

时间	先行指数	一致指数	滞后指数	预警指数
2013-02	98.8	95.7	100.0	26
2013-03	98.8	95.3	99.5	26
2013-04	98.5	95.2	99.2	25
2013-05	98.3	95.5	99.4	26
2013-06	98.4	96.1	100.0	27
2013-07	98.6	96.7	100.9	28
2013-08	98.8	97.1	102.0	27
2013-09	98.7	96.9	102.8	27
2013-10	98.2	96.3	103.6	26
2013-11	97.3	95.3	104.0	25
2013-12	96.3	94.3	104.1	24
2014-01	95.3	93.4	104.3	23
2014-02	94.4	92.6	104.3	22

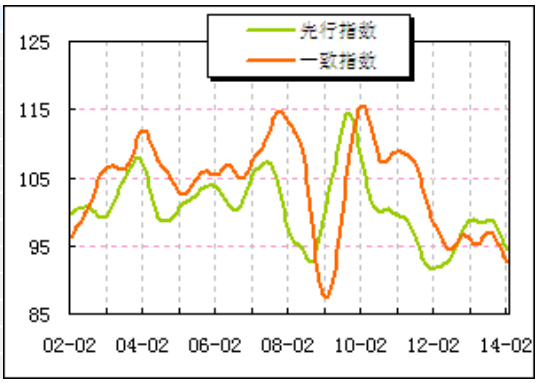


Fig.4-6 China economy index of SIC[50]

Founded in 1988, SIC is located in Beijing. As its affiliate, China Economic Information Network (CEIN) set up China Economy Monitor and Warning System in 2006. There are a series

[49] Data source: http://www.cemac.org.cn/gywm.html

[50] Data source: http://serve.cei.gov.cn/index/index/

of economy cycle indicators named 中经指数(zhong jing zhi shu) as its products in the system. They also have leading, coincident and lagging indicators. These indicators are released monthly on their website like Fig. 4-6.

Founded in 2009, CCIEE is also located in Beijing. It is a comprehensive association with the mission of promoting international economic research and exchanges and providing consulting service. CCIEE attracts experienced economic researchers and has close connection with economic research resources in various fields. The main scope of business and services of the CCIEE is as follows: ① to study economic issues, ② to conduct economic exchanges domestically and internationally, ③ to promote economic cooperation domestically and internationally, ④to provide consulting services.

CCIEE developed 5 kinds of prosperity indices: ①CCIEE-World Economy Prosperity Index, ②CCIEE-Commodity Price Index, ③CCIEE-SJTU Global Shipping Prosperity Index, ④ CCIEE-China Economy Prosperity Index and ⑤ CCIEE-Evaluation Index for China Transformation of the Mode of Economic Development. Indicators 1~3 are about global economy. Indicators 4~5 are about domestic economy.

⑶Economist

Chinese economists had research on business cycle theory since 1950s. At first, the main function of their papers was to introduce the research result of western economists. WU Dakun (1959) and ZHU Jingyao (1965) oppugned the correctness of business cycles theory and methodology.

In 1980s, Chinese economists researched the model of economy growth. WU Jiabei and DONG Wenquan (1986) wrote a teaching book “Economics Models and its Application”. In this book, leading, coincident and lagging indicators were introduced to Chinese students. SHI Zuhui (1988) studied on the macro economy monitoring index system of Japan. HUANG Yuncheng, etc. (1988) had a discussion on diffusion index and its function in business cycles. CAO Changwei, etc. (1989) constructed a new model for Balanced Growth Prosperity Index.

In 1990s, Chinese economists started to construct Chinese business cycles Index. WANG Shilin, LUO Li (1996) researched the business cycle of Chinese macro economy. DONG Wenquan, etc. (1998) systematically analyzed the methodology of economic cycles theory and put forward the China’s economy cycles indicators. XIANG Jintian, etc.(2000) suggested to set up the monitoring and pre-warning indicator system. Due to the lack of data support, these indicator systems just stopped on the papers.

In 2004, State Information Center (SIC) set up an information system for economy analysis. Then Chinese economists had the chance to put their model of business cycles indicator system into practice. CHEN Lei (2004) analyzed the relationship of enterprise prosperity situation and macro economy operation. SUN Guangsheng(2006) gave an analysis on economic and industrial fluctuations with the huge data during 1986-2003. WANG Jinming (2006) analyzed the features of the business cycles in the transient China. WANG Jinming, etc.(2007) constructed SW-Type leading indices. SHI Zhuxian, etc. (2007) made an empirical research for business cycle in China with the multivariate Markov regime-switching model. GUO Guofeng, etc. (2010) made an empirical test for the effectiveness of China’s macroeconomic leading index and coincident index.

After 2011, the research on business cycles in China became more detail and in-depth. TIAN Qiusheng and TANG Hanqing (2011) made the research on cycle division and fluctuation trend for China economy. ZOU Zhanyong, etc. (2012) tried to forecast the turning point of economy cycles with composite index. ZHENG Jingping and his team made a systematic study on China's economic cycles monitoring indicators system. They found many problems in the rapid development of China economy cycle theory and gave some solutions. CHENG Maolin, etc. (2013) set up the combination forecasting model for business cycles and gave the application areas.

Therefore, China's research results are significant behind Japan, more behind the United States. This is the reason for CEMAC and Goldman Sachs jointly issued the leading and coincidence indicators.

Meanwhile, it is necessary for producing and publishing the business cycle indicators to construct a large scale state economy database. This kind of database is infrastructure of economy research.

4.3 Prosperity indices for industry economy

The prosperity indices for national macro-economy are widespread in the world. Not only developed countries but also developing countries have it. With the development of business cycle indicators, the prosperity indices for industry economy are developed rapidly. These industry prosperity indices are the parts of national macro-economy indices. Meanwhile, they can describe the situation of the industry in the country. This section will introduce the application of prosperity indices in manufacture, real estate and logistics industries.

4.3.1 Manufacture industry

⑴Some research results

When creating business cycles indicators, NBER (1923) selected some indicators from manufacture industry like unemployment rate, consumption of raw material, output of finished product and capacity of normal production. Wesley C. Mitchell (1943) wrote that inventory of manufacture enterprise should be an important lagging indicators.

Mark Gertler and Simon Gilchrist (1994) analyzed the response of small versus large manufacturing firms to monetary policy. They found that small firms account for a significantly disproportionate share of the manufacturing declined that follows tightening of monetary policy. They played a surprisingly prominent role in the slowdown of inventory demand. Large firms initially borrow to accumulate inventories. After a brief period, small firms quickly shed inventories. Robert J. Hodrick and Edward C. Prescott (1997) proposed a procedure for representing a time series as the sum of a smoothly varying trend component and a cyclical component. They documented the nature of the co-movements of the cyclical components of a variety of macro- economic time series. They found that these co-movements were very different than the corresponding co-movements of the slowly varying trend components.

Joseph H. Davis (2004) introduced an annual index of American industrial production consistently defined from 1790 until World War I, as a remedy for the notorious deficiency of pre-Civil War US macroeconomic data. The index incorporates 43 quantity-based annual series (most entirely new) in the manufacturing and mining industries in a manner similar to the Federal

Reserve Board's monthly industrial production index.

Ard H. J. den Reijer (2007) identified the deviation cycles in the manufacturing industry of nine OECD countries with applying the Christiano-Fitzgerald band-pass filter. A regression based test statistic was applied to test for duration dependence. Moreover, the international linkage between the cyclical motions in the manufacturing industry of two countries is investigated by measuring the degree of synchronization. In addition to measuring the cyclical fluctuation, a composite leading indicator is constructed which replicates and predicts the deviation cycle in the manufacturing industry.

⑵Some application

In 1920s, there were no enough statistic data to support the publication of the business cycle indicators, even in manufacture industry. Business Tendency Surveys were carried out to obtain qualitative information for use in monitoring the current business situation and forecasting short-term developments. Information from these surveys has proved of particular value in forecasting turning points in the business cycle. Some of the earliest surveys were carried out by trade associations, such as the Confederation of British Industries and the ifo Institut für Wirtschaftsforschung in Germany, although the national statistical office of France, the Institut national de la statistique et des études économiques (INSEE), has also played a prominent role in this area since the 1950s.

Compared to statistical surveys, which usually cover only variables on one aspect of an enterprise’s activity, business tendency surveys collect information about a wide range of variables selected for their ability, when analyzed together, to give an overall picture of a sector of the economy. For example, most business surveys collect information on production, order books, new orders, stocks of finished goods, exports, employment and prices.

Central banks, for example in Japan and Belgium, have also been carrying out business tendency surveys for many years. They need information on the current economic situation that is more up to date than the statistics released by official statistical agencies. A recent trend is for more national statistical offices to conduct business tendency surveys – Canada and Australia are examples among OECD Member countries and most national statistical offices in transition countries in Europe and Central Asia now also have their own business tendency surveys.

Some of the early surveys covered enterprises engaged in several different kinds of activities, and this is still the case with most of the surveys carried out in Asia and Latin America. Increasingly however, there is a trend towards activity-specific surveys using questionnaires and sample selection tailored to the particular characteristics of different activities.

In US, there are many indicators for manufacture industry. The most famous is Purchasing Managers' Index (PMI) which can be found under "ISM Reports On Business" on the ISM home page. The surveys are released shortly after the end of the reference period. The actual release dates depend on the sector covered by the survey. Manufacturing data are generally released on the 1st working day of the month, followed by construction on the 2nd working day and services on the 3rd working day.

As the producer of PMI, the Institute for Supply Management (ISM) is in Tempe, Arizona. It began to produce the report for the US in 1948. The data for the index are collected through a survey of 400 purchasing managers in the manufacturing sector on five different fields, namely,

production level, new orders from customers, speed of supplier deliveries, inventories and employment level. Respondents can report either better, same or worse conditions than previous months. For all these fields the percentage of respondents that reported better conditions than the previous months is calculated.

China Purchase Manager Index (CPMI) is joint published monthly by the National Bureau of Statistics and China Federation of Logistics and Purchase since June 2005. It is a composite leading indicator by which the market tendency can be understood rapidly and timely. It includes two parts: manufacture and non-manufacture. The China Manufacture Purchase Manager Indicator system is combined by 11 indicators: new order, produce, employee, supplier distribution, inventory, new export order, purchase, inventory of finish goods, purchase price, import, backlog order. If China Manufacture Purchase Manager Index (CMPMI) is above 50%, the manufacture industry of China is in expansion. If CMPMI is below 50%, the manufacture industry of China is in recession. KONG Xianli and HE Guangjian (2007) developed further the Prospertiy Index of China Auto Industry.

4.3.2 Real estate industry

The business cycle indicator of real estate industry became a part of national business cycle index in about 1960s. At first it was one of PMI indicators. In 1990s, with rapid development of real estate industry, the real estate cycle became more and more important in nation business cycles.

⑴Some research results

Karl E. Case (1992) improved that the dramatic real estate cycle, which began with a housing price boom in the Massachusetts between 1984 and 1987, was an important element that not only contributed to but also very significantly amplified the economic fortunes and misfortunes of the Commonwealth and the region. Ayse Can and Isaac Megbolugbe (1994) constructed a house price indices model that do not incorporate the underlying spatial structure in housing data sets. They illustrated the importance of spatial dependence in both the specification and estimation of hedonic price model. Waldo L. Born and Stephen A. Pyhrr. (1994) used a cycle valuation model to evaluate linkages between real estate supply and demand cycles, equilibrium price cycles, inflation cycles, rent rate catch-up cycles, and property life cycles; translates their effects on cash flow variables; and demonstrates their significant impact on asset value. The study results suggested that appraisers should develop cash flow models that explicitly incorporate cycle impacts in order to produce realistic present value estimates and valuation conclusions. Further, the market research process must be redefined and reorganized to produce information and data for use in cycle models. Ronald W Kaiser (1997) examined the possible causes of the 1985-1993 boom/bust in real estate and the periodicity of such major real estate cycles. He found that some evidence from even earlier periods suggested a periodicity for such real estate boom/busts of some fifty to sixty years.

Stephen A. Pyhrr, etc. (1999) synthesized relevant research and commentary on real estate cycles in a micro-decision-making context and discusses their strategic implications for investors and portfolio managers. They set up eight cycle models which presented an analytical definition of cycles, seek to measure cyclical impacts on key investment variables in an ex ante framework and provided insight into some aspect of investment timing or other property/portfolio decisions.

William C. Wheaton (1999) demonstrated that different types of real estate can had very different cyclic properties. He built a stock-flow model in which the future expectations of agents, the development lag, the degree of durability and market elasticity all can be deferent.

With a structural vector autoregressive approach, Matteo Iacoviello (2002) identified the main macroeconomic factors behind fluctuations in house prices in France, Germany, Italy, Spain, Sweden and the UK. Quarterly GDP, house prices, money, inflation and interest rates were characterized by a multivariate process driven by supply, nominal, monetary, inflationary and demand shocks. Tight money leads to a fall in real house prices; house price responses are hump-shaped; the responses of house prices and, to a lesser extent, GDP to a monetary shock can be partly justified by the different housing and financial market institutions across countries; transitory shocks drive a significant part of short-run house price fluctuations. Morris A. Davis and Jonathan Heathcote (2005) thought the percentage standard deviation of residential investment is more than twice that of nonresidential investment in United States. In addition, GDP, consumption, and both types of investment co-move positively. They reproduced these facts in a calibrated multisector growth model where construction, manufacturing, and services are combined, in different proportions, to produce consumption, business investment, and residential structures. Matteo Iacoviello (2005) developed and estimated a monetary business cycle model with nominal loans and collateral constraints tied to housing values. Demand shocks, the financial accelerator, collateral effects, nominal debt and policy evaluation were discussed one by one.

Edward E. Leamer (2007) thought a modified Taylor Rule would depend on a long-term measure of inflation having little to do with the phase in the cycle, and, in place of Taylor's output gap, housing starts and the change in housing starts, which together form the best forward-looking indicator of the cycle of which he was aware. This would create pre-emptive anti-inflation policy in the middle of the expansions when housing is not so sensitive to interest rates, making it less likely that anti-inflation policies would be needed near the ends of expansions when housing is very interest rate sensitive, thus making our recessions less frequent and/or less severe. Robert J. Shiller (2007) looked at a broad array of evidence concerning the recent boom in home prices, and considers what this means for future home prices and the economy. A psychological theory, that represents the boom as taking place because of a feedback mechanism or social epidemic that encourages a view of housing as an important investment opportunity, fits the evidence better.

⑵Some application

In United States, there are a lot of vary house price indices made by different institutions. House Price Index (HPI), FHFA/OFHEO, Case-Shiller Index (CSI) and FNC Residential Price Index (RPI) are delegates.

HPI is made by The US Federal Housing Finance Agency (formerly Office of Federal Housing Enterprise Oversight, OFHEO). It is a weighted, repeat-sales index, quarterly broad measure of the movement of single-family house prices. The HPI measures average price changes in repeat sales or refinancings on the same properties in 363 metropolises. The HPI was developed in conjunction with OFHEO's (now FHFA) responsibilities as a regulator of Fannie Mae and Freddie Mac. It is used to measure the adequacy of their capital against the value of their assets, which are primarily home mortgages. On July 30, 2008 OFHEO became part of the new Federal Housing Finance Agency (FHFA). The index is now termed the FHFA HPI.

The Case-Shiller Indices are measured monthly and tracks repeat sales of houses using a modified version of the weighted-repeat sales methodology proposed by Karl Case and Robert Shiller and Allan Weiss. This means that, to a large extent, it is able to adjust for the quality of the homes sold, unlike simple averages. Therefore, Case-Shiller Indices have long lag time. Typically. It takes about 2 months for S&P to publish the results, as opposed to 1 month for most other monthly indices and indicators.

FNC Inc. publishes the Residential Price Index, which is based on data collected from public records blended with data from real-time appraisals of property and neighborhood attributes. The RPI is the mortgage industry's first hedonic price index for residential properties. It is constructed to gauge price movement among non-distressed home sales, and excludes sales of foreclosed properties. As a monthly tracking index, the RPI has a lag time of about two months.

The Economist is an weekly newspaper. It collects HPI and made some pictures on its website. Fig.4-7 shows two of them. It is very obvious that the house price in New York in 2013 is more expensive than before 2000 in left picture. House price in Britain is more expensive then in United States, and Japan goes back to 1970s in right picture. These 2 pictures give other examples that price index cannot show the prosperity lever for the market. The prosperity index is needed in certain industry.

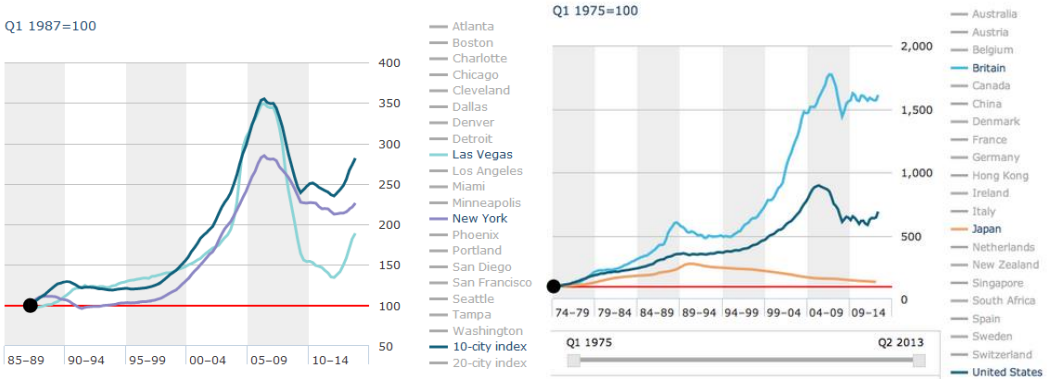


Fig.4-7 The HPI in US and on the Earth[51]

China Index Academy (CIA) is the largest independent property research organization with more than 15 offices in China. CIA has been aiming at providing comprehensive and accurate property/land data in a timely manner and generating key market insights for our valued customers. Currently, we have experienced research teams to cover real-time transaction data in 300 cities across China.

China Real Estate Indicator System (CREIS) includes 4 group indicators: Real Estate Price Indices in 10 Key Cities (HPI-10), Real Estate Price Indices in 100 Key Cities (HPI-100), New House Price Indices (NHPI) and Secondhand House Price Indices (SHPI).

China National Statistic Bureau developed the monthly prosperity index of national real estate development named Real Estate Climate Index (RECI) in 1997. The initial point of RECI is 100 in Jan. 2000. If RECI is between 95 and, the real estate market is suitable. If RECI is below 95, the market is too cold. If RECI is above 105, the market is too warm.

[51] Data source: http://www. economist.com/blogs/graphicdetail/2014/02/us-house-prices

4.3.3 Summary

Besides manufacture industry and real estate market, economist also developed vary prosperity indices (or business cycle indices) for many industries like transportation Industry, logistics industry, travel market, etc.. Most algorithm of them is same with national economy cycle index, includes leading, coincident and lagging indicators. Difference are the indicators chosen as the characters of industries.

Therefore, for global maritime transport market, only freight index cannot give enough information for the situation of the global maritime transport market. Some prosperity indices may also be needed not only for academy research but also for correct investment in maritime transport market. Actually, some scholars realized also only BDI cannot describe the global maritime transport correctly. ZHOU Dequan and ZHEN Hong (2010) set up the China Shipping Prosperity Index (CSPI) indicator system and released the index since winter season of 2009. ZHANG Yu, WANG Bo and TAN Zhen-dong (2011) applied the rhombus inference model to establish the shipping risk early-warning index system based on element extension theory. LI Gang (2012) gave a detail description of CSPI series.

The indicator structure of the China Shipping Prosperity Index Series (CSPIs) is shown in Fig.4-8. It combined with four sub-indexes: China Shipping Prosperity Index (CSPI), China Shipping Confidence Index (CSFI), China Shipping Prosperity Alertness Index (CSAI) and China Shipping Prosperity Composite Index (CSCI).

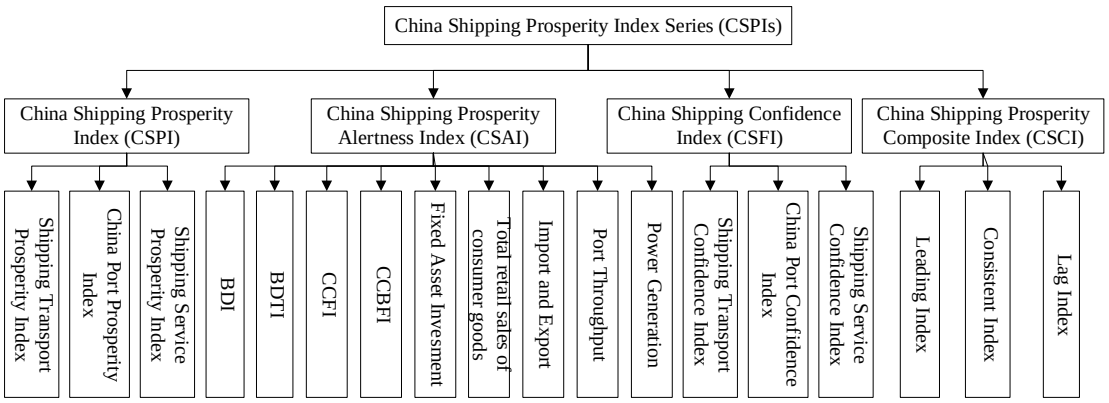


Fig. 4-8 The indicator structure of the CSPIs

There are 18 indicators in third lever in which only 9 indicators belonging to CSAI are objective quantitative. The data of other 9 indicators are from the investigation of over 230 enterprises quarterly. Therefore, some question for the choose of indicators happened: BDI and BDTI are the global indicator not only for China, why did they be listed in? For other 9 investigation indicators, we could not find the questionnaire. Meanwhile, the subjective judgment of interviewee can make some mistake easily. We cannot find enough information about the method to filter the suspicious data.

Although the CSPIs are not perfect, we still think it gave a signal that is the market needs a prosperity index. It is the important reason to make this research in this paper.

Chen J. etc.(2014) published their research paper for the prosperity index system of Chinses

dry bulk shipping market in the Transportation Research Board Annual Meeting. They applied the time difference correlation analysis and cluster analysis to classify these indicators into three categories of the leading, coincident and lagging indicators, presented to the economic cycle, diffusion indices and composite indices of local shipping prosperity by using the method of factor analysis.

Both Zhou and Chen paid attention to the prosperity index of China shipping market. As the maritime transport market has very strong globalization characteristic, we consider the prosperity index in this industry only can be divided according to the vessel type not the region. That means the prosperity index for dry bulk market, tanker market or container liner market are reasonable, but the prosperity for Shanghai market, Tokyo market or London market should be circumspect.

No matter what the defects is, their work at least proves the necessity of the research on the prosperity index of global maritime transport market (PIGMT).

Chapter 5 Algorithm and its application of the PIGMT

Chapter 3 gave the index framework for global maritime transport market with Fig.3-8 which included the PIGMT. Chapter 4 discussed the theory of the prosperity index and its application in various industries. This chapter will design a new index for the global maritime transport market following the method of prosperity index. This new index is calculated by combining various indicators of global trade, maritime freight, maritime cost and vessel supply. Therefore it can fully display the real situation of the global maritime transport market.

5.1 Index system structure

Based on the index framework shown in Fig.3-8, there are three methods to calculate the prosperity index of the global maritime transport market. One is to calculate every the prosperity index for each sub market first, then combine them into a composite index for whole market. Second is to calculate every prosperity index for each country first, then combine them into a composite index for the global market. According to the methodology of Zhou (2010) or Chen (2014) every country can issue its shipping prosperity index. Third is to calculate the prosperity index of global maritime transport market (PIGMT) directly with all selected indicators of the whole market. As the data limitation, this chapter will try to develop the methodology of the PIGMT according to the third way.

5.1.1 Selection of prosperity index type

Recent advances in information technology make it possible to access in real time, at a reasonable cost, thousands of economic time series for major developed economies. This raises the prospect of a new frontier in macroeconomic forecasting, in which a very large number of time series are used to forecast a few key economic quantities, such as aggregate production or inflation. Time series models currently used for macroeconomic forecasting, however, incorporate only a few series: vector auto regressions, for example, typically contain fewer than 10 variables. Although variable selection procedures can be used to choose a small subset of predictors from a large set of potentially useful variables, the performance of these methods ultimately rests on the few variables that are chosen.

As the global maritime transport market is a complex market which has many different parts. According to the research result of the NBER, the diffusion index and composite index are suitable for this market.

⑴ Composite index

Composite index is a term that is used to refer to a grouping of indexes and equities that are combined in a generalized way and provide a useful statistical measure of the overall sector performance with time.

The composite indexes are calculated by composing month-to-month percentage changes in multiple economic indicators. As a simplified example, assume that one of the composite indexes is constructed from two indicators, Indicator A and Indicator B ("y1" and "y2" in the illustration below). In a certain month, Indicators A and B are higher than the previous month by 1 percent and 0.5 percent respectively ("γ1" and "γ2" in the same illustration). These change rates are averaged, and the average is multiplied by the previous month's level of the composite index to

obtain the current months.

The change rates with different volatilities are subjected to a process called "normalization" before averaging so that they can be evaluated on a common basis. Assume a situation in which Indicator A shows an upward trend and large monthly fluctuations, while Indicator B shows a flat trend and small monthly fluctuations. In this situation, the change rates have different meanings between Indicator A and B.

The normalization process is performed taking into consideration two types of elements: trend and amplitude. Assume that Indicator A has a trend of 2 percent and an amplitude of 0.5 percent, the normalized percentage change rate for Indicators A is calculated as follows:

(Change rate for the current month 1 - Trend 2) / (Amplitude 0.5) = -2.

Similarly, assume that Indicator B has a trend of 0 percent and an amplitude of 0.2 percent, the normalized percentage change rate for Indicator B is calculated as follows:

(Change rate for the current month 0.5 - Trend 0) / (Amplitude 0.2) =2.5.

Then, the "composite normalized percentage change rate," Z, is calculated as 5-1, by averaging the normalized percentage change rates of Indicators A and B:

$$Z = (-2 + 2.5) / 2 = 0.25 \quad (5\text{-}1)$$

Because Z is an absolute number with no dimension, it should be adjusted back to the percentage change of the original economic indicators by taking the following two steps: (1) the composite normalized percentage change Z is multiplied by the composite amplitude σ, which is obtained by averaging the amplitudes of Indicator A and B; and (2) the composite trend μ is added to the result of step (1). The result of the two steps represents the composite " month to month percentage change " V. Then, the current month's composite index is obtained by multiplying V by the previous month's level of the composite index. Individual indicators' month-to-month percent change rate is calculated using a "symmetric percentage change." The symmetric percentage change uses for the denominator an average of the previous and current month values (mean value), instead of the previous month's level, as in the ordinary calculation of month-to-month ratios. When calculating the composite index based on V, the symmetric percentage change formula is used inversely.

Composite index calculation flow and examples of values (when the composite index is constructed from two indicators)

The “symmetric percentage change” is used in the calculation of the month-to- month percentage change rate γ, as well as in the calculation of the composite index inversely from V with the formula marked with (*) .

The symmetric percentage change uses the average of previous and current months as denominator：

$$\gamma_t = (y_t - y_{t-1}) / ((y_t + y_{t-1})/2 * 100. \quad (5\text{-}2)$$

(When γ_t is a ratio or changer rate, it is replaced with the month-to-month difference in the level of y_t.)

The calculation method is as follows.

Step 1: The previous formula is used for calculating the symmetric percent change ($r_i(t)$) of individual series ($y_i(t)$), as in the following. In the notation below, *i* subscript refers to the number assigned to each indicator.

$$r_i(t) = 200 \times \frac{y_i(t) - y_i(t-1)}{y_i(t) + y_i(t-1)} \tag{5-3}$$

If the given time series is zero or a negative value, or is already in percentage form, simple arithmetic differences are calculated.

$$r_i(t) = y_i(t) - y_i(t-1) \tag{5-4}$$

Then, outliers (found only in the specific movement of each indicator as below) are replaced using the following step.

Step 1-1: The trend of individual series (mean percent change $\mu_i(t)$) is calculated by the 60-month backward moving average.

$$\mu_i(t) = \frac{\sum_{\tau=t-59}^{t} r_i(\tau)}{60} \tag{5-5}$$

Step 1-2: Percent change normalized by interquartile range ($z_i(t)$) is calculated by applying the following formula.

$$z_i(t) = \frac{r_i(t) - \mu_i(t)}{Q3_i - Q1_i} \tag{5-6}$$

$Q1_i$ is the first quartile in the interquartile range and $Q3_i$ is the third quartile in the interquartile range of the symmetric percent change ($r_i(t)$).

Step 1-3: Median of percent change normalized by interquartile range ($z_i(t)$) is chosen for the common cyclical movement ($ZC_i(t)$).

$$ZC(t) = Median \quad of \quad z_i(t) \tag{5-7}$$

Step 1-4: The specific movement of each indicator ($z_i(t)'$) is calculated by subtracting the common cyclical movement from percent change normalized by interquartile range.

$$z_i(t)' = z_i(t) - ZC(t) \tag{5-8}$$

Step 1-5: The symmetric percent change for the specific movement of each indicator ($r_i(t)'$) is calculated by adding up trend and the specific movement of each indicator multiplied by interquartile range.

$$r_i(t)' = z_i(t)' \times (Q3_i - Q1_i) + \mu_i(t) \tag{5-9}$$

Step 1-6: The symmetric percent change for the common cyclical movement ($rc_i(t)$) is calculated by multiplying the common cyclical movement by interquartile range.

$$rc_i(t) = ZC(t)' \times (Q3_i - Q1_i) \tag{5-10}$$

Step 1-7: Outliers in the symmetric percent change for the specific movement of each indicator ($r_i(t)'$)are replaced using the following formula.

$$\psi_1(r_i(t)') = \begin{cases} -k'(Q3_i' - Q1_i') : r_i(t)' < -k'(Q3_i' - Q1_i') \\ r_i(t)' : -k'(Q3_i' - Q1_i') \le r_i(t)' \le k'(Q3_i' - Q1_i') \\ k'(Q3_i' - Q1_i') : k'(Q3_i' - Q1_i') < r_i(t)' \end{cases} \tag{5-11}$$

$Q1_i'$ is the first quartile in the interquartile range and $Q3_i'$ is the third quartile in the interquartile range of the symmetric percent change for the specific movement of each indicator ($r_i(t)'$).

Then, the symmetric percent change for the common cyclical movement is added.

$$\psi_2(r_i(t)') = \psi_1(r_i(t)') + rc_i(t) \tag{5-12}$$

Step 2: Again, the trend of individual series (mean percent change $\mu_i(t)'$) is calculated by the replaced 60-month backward moving average.

$$\mu_i(t)' = \frac{\sum_{\tau=t-59}^{t} \psi_2(r_i(\tau)')}{60} \tag{5-13}$$

Percent change normalized by interquartile range ($z_i(t)''$) is calculated by applying the following formula.

$$z_i(t)'' = \frac{\psi_2(r_i(t)') - \mu_i(t)'}{Q3_i - Q1_i} \tag{5-14}$$

Step 3: Composite percentage change ($V_{(t)}$)is calculated by adding up trend (composite mean percent change, $\bar{\mu}(t)$) and the mean of percent change normalized by interquartile range (composite percent change normalized by interquartile range, $\bar{Z}(t)$). In this process, composite percent change normalized by interquartile range is multiplied by the mean of interquartile ranges (composite interquartile range,$\overline{Q3-Q1}$) so that the levels of the trend component and the cyclical component coincide.

$$\bar{\mu}(t) = \frac{1}{n} \times \sum_{i}^{n} \mu_i(t)' \tag{5-15}$$

$$\overline{Z}\ (t)=\frac{1}{n}\times\sum_{i} z_i\ (t)'' \tag{5-16}$$

$$\overline{Q3-Q1}\ =\frac{1}{n}\times\sum_{i}^{n}(Q3_i-Q1_i) \tag{5-17}$$

$$V\ (t)=\overline{\mu}\ (t)+\overline{Q3-Q1}\ \times\overline{Z}\ (t) \tag{5-18}$$

where *n* represents the number of indicators.

Step 4: As in the previous calculation method of composite indexes, composite percent change is cumulated. Finally, the index is rebased so that the value for the reference year is 100.

$$I\ (t)=I\ (t-1)\times\frac{200+V(t)}{200-V(t)} \tag{5-19}$$

$$CI\ (t)=\frac{I(t)}{I}\times 100 \tag{5-20}$$

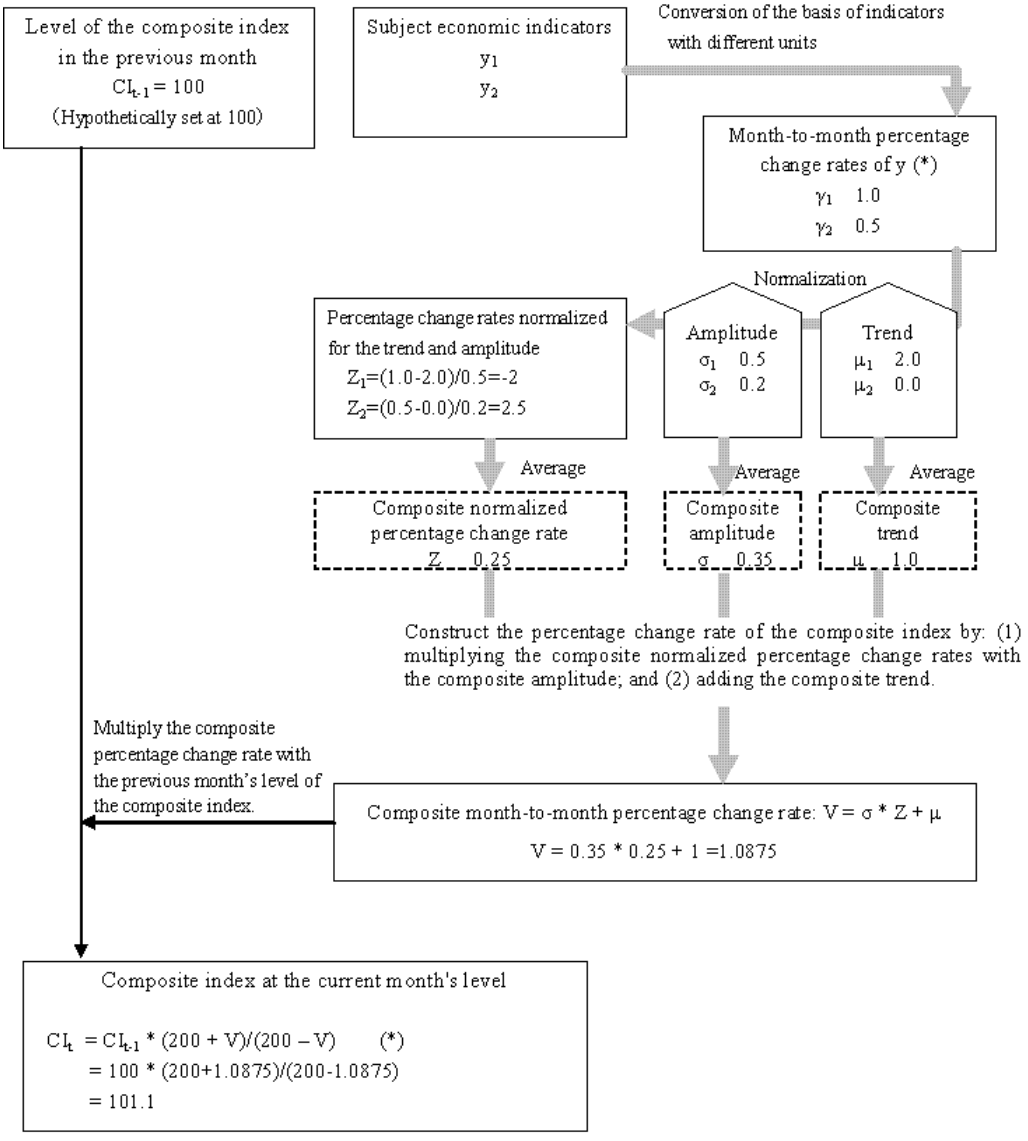


Fig. 5-1 Calculation process for diffusion index

(I is the average of the reference year $I_{(t)}$ in 5-19, 5-20)

Notes for calculation：

For calculating the leading composite index and the lagging composite index, the trend component of coincident composite index is applied as in the previous method.

The threshold for Winsorized mean, k', is uniformly set as 2.02, by which 5 percent of the data in the coincident series from January 1985 to December 2012 are regarded as outliers.

With regard to dealing with missing data of indicators because of late publication in calculating composite indexes, the trend is calculated by using the available data of all the indicators at that time. For example, if an indicator has data for only 57 months, then the 57-month data are used in calculating the trend. On the other hand, when calculating composite percentage change normalized by interquartile range, indicators with missing data are excluded. As a result, the latest composite percent change normalized by interquartile range does not include all of the indicators.

⑵Diffusion index

The diffusion index is one of the many different tools used by technical analysts to increase the probability of picking winning stocks. Also known as the advance/ decline diffusion index.

The diffusion index can help an economist or trader interpret any of the composite indexes of the BCI more accurately - the diffusion index breaks down the indexes and analyzes the components separately, exhibiting the degree to which they are moving in agreement with the dominant direction of the index.

James H Stock and Mark W Watson studied forecasting a macroeconomic time series variable using a large number of predictors. The predictors were summarized using a small number of indexes constructed by principal component analysis. An approximate dynamic factor model serves as the statistical framework for the estimation of the indexes and construction of the forecasts. The method is used to construct 6-,12-, and 24-monthahead forecasts for eight monthly U.S. macroeconomic time series using 215 predictors in simulated real time from 1970 through 1998. During this sample period, these new forecasts outperformed univariate autoregressions, small vector autoregressions, and leading indicator models.

⑶Summary

It is necessary for the PIGMT to be a composite index. Therefore, the algorithm of the PIGMT must follow the composite index. The main function of diffusion index for PIGMT is to find the inflection point. The algorithm of composite index also can give it. Therefore, let us follow the algorithm of composite index first.

5.1.2 Framework and indicator system of the PIGMT

⑴Framework of the PIGMT

According to the methodology of business cycle indices, there are three indicator groups: leading, coincident, and lagging indicators. Link them to the global maritime transport market, framework of the PIGMT as listed in Fig.5-2.

①For leading indicators

Leading indicators are indicators that usually change before the economy as a whole change. They are therefore useful as short-term predictors of the economy. For the global maritime transport market, various global trade indicators are in the leading group. As there are many

indicators in global trade market, the identification of specific indicators will be based on the requirement to select algorithm. Meanwhile, for freight indicators, the Forward Freight Agreements (FFA) of the Baltic Exchange and so on are suitable to be parts of the leading indicator. Likewise, for oil price indicator, the future price like WTI and Brent Crude can be the candidate indices of the leading indicators.

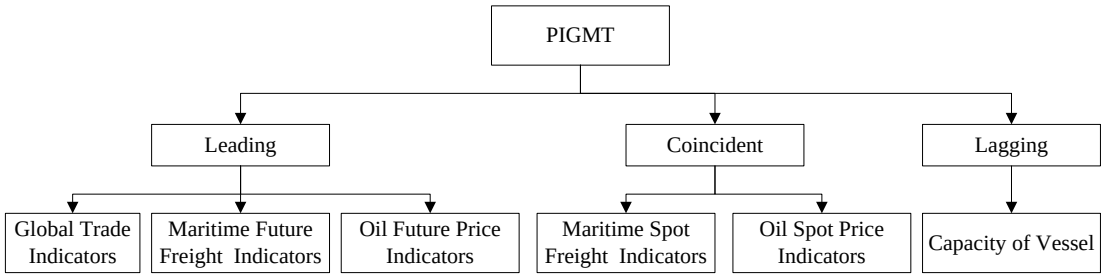


Fig. 5-2 Framework of the PIGMT

②Coincident indicators

Coincident indicators change at approximately the same time as the whole economy, thereby providing information about the current state of the economy. A coincident index may be used to identify, after the fact, the dates of peaks and troughs in the business cycle. Coincident indicators of the PIGMT are mainly from global maritime transport market. As fuel price is the important factor for cost of maritime transport industry, some indicators of global fuel market should be considered. The identification of specific indicators will be based on the requirement to select algorithm.

③For lagging indicators

Lagging indicators are indicators that usually change after the economy as a whole does. Typically the lag is a few quarters of a year. From the side of supply chain, new building and demolition of vessels is guided by maritime transport industry. Therefore some indicators of ship market will be considered in lagging group. The identification of specific indicators will be based on the requirement to select algorithm.

⑵Research on optional indicators

There are many indicator databases for global economy, maritime market, oil market and ship market. Area and local indicators are not considered in the PIGMT. According to the sources of indicators, they can be divided into trade indicators, maritime freight indicators, cost indicators, supply capacity indicators, etc. Then they can be classified as leading, coincident, and lagging groups by their characteristics.

①Indicator selection principles

The principles of the indicators selection for the PIGMT are as follow:

Principle A: global indicator

Principle B: quantitative indicator

Principle C: recognized indicator, at least in maritime transport market

Principle D: no or very weak correlation between indicators

Principle E: for every sub-market, no more than 2 indicators

②Trade indicators

There are hundred indicators for macro-economy and international trade in the world. Table 5-1 gives some optional global trade indicators that can be found in the database of UNCTAD Statistics. World Trade Organization also gives many trade statistics data on its website. As the member of WTO does not include all of countries on the earth, the data from UNCTAD will be better for the calculation of the PIGMT.

Tab. 5-1 Some optional global leading indicators[52]

Item	No.	Indicators
Trade trends	1	Volume growth rates of merchandise exports and imports
	2	Values and shares of merchandise exports and imports
	3	Value growth rates of merchandise exports and imports
	4	Merchandise trade balance
	5	Value, volume and unit value indices of merchandise exports and imports
	6	Values and growth of exports and imports of total services
	7	Values, shares and growth of exports and imports of total services
	8	Exports and imports of goods and services
Trade structure	9	Intra-trade of regional and trade groups by product
	10	Merchandise trade matrix - product groups, exports in thousands of dollars
	11	Merchandise trade matrix - detailed products, exports in thousands of dollars
	12	Merchandise trade matrix - product groups, imports in thousands of dollars
	13	Merchandise trade matrix - detailed products, imports in thousands of dollars
	14	Value, shares and growth of services exports and imports by service-category
Trade indicator	15	Terms of trade indices and purchasing power indices of exports
	16	Bilateral concentration indices of merchandise exports and imports
	17	Comparative diversification indices of merchandise exports and imports
	18	Concentration and structural change indices of merchandise exports and imports by product
	19	Merchandise trade complementarity
	20	Merchandise trade specialization index
	21	Merchandise trade correlation index
	22	Goods and services trade balance indicators
	23	Goods and services trade openness

As the research focus on maritime transport market, all of indicators about trade structure, trade indicator and service trade is not necessary. Actually, the volume and value of merchandise exports are important two indicators for maritime transport market. Further, the values of grain, iron ore, coal, crude oil and products trade are more important than total value of merchandise as the freight rates are about these special goods. Fortunately, under the volume and value of merchandise exports, UNCTAD gives more detail data about the trade value of special goods and

[52] Data source: http://unctad.org/en/Pages/Statistics.aspx

their transportation volume monthly.

The German organization RWL issues the Container Throughput Index (CTI). The CTI has been widely adopted by OECD, IMF etc.. The volume of global port throughput can reflect the situation of the global liner market only, not all of the market. Even in liner market, container port throughput just showed the handled volume of the port company, not transport volume by carrier. There are many load operation only for transfer (forwarder a container from A vessel to B vessel) on the terminal. For this paper, as the first data of the CTI started since 2008, the PIMGT started since 2000, the CTI cannot be one of the candidate indicators of the PIGMT.

③Freight rate indicators

Section 2.2 gives 27 maritime freight indicators and their sources for maritime transport market. From these indicators, some representative indicators can be selected for three main transport markets: tanker market, dry bulk market, container liner market (see table 5-2). Because there is not any global freight index for dry cargo market, so the indicators for dry cargo market will be ignored. Fortunately, the share of every branch of dry cargo market is very small in the global maritime transport market (over 30 branches have less than 20% share totally in transport volume).

Tab. 5-2 Selected indicators in freight market

No.	Indicator	Data source	Market
1	BCI	Baltic Exchange	Dry bulk
2	BPI		
3	BDI		
4	BDTI		Tanker
5	CTRI	Clarkson Research Service	Container Liner

The BCI is mainly for iron ore seaborne transport. The BPI is mainly for grain seaborne transport. Iron ore is the base resource for industry. Grain is the base food for human life. The BDI is a composite index for dry bulk seaborne transport. So these 4 indicators are selected as the candidate indicators which are represented in dry bulk market for the PIGMT.

As the base indicators for tanker market, the WS is very detail for every route and ship type. There is no composite indicator for global tanker market in the WS system. So the BDTI calculated by some of the WS in dirty oil seaborne transport market is chosen as the representative of tanker market.

As there is no any indicator for global liner market, the CCFI and the SCFI just are the indicators for China export container freight market, the CTRI is selected as the representative for liner market. Actually, liner freight includes cost of navigation, terminal charge and management cost, the CTRI may be suitable for global liner market.

④Price indicators of petroleum

Most of merchant vessel use petroleum as its power source. The price of petroleum becomes the important cost factor of shipping company. To account the effect of oil price fluctuation on the prosperity of maritime transport industry, it is necessary to choose some typical oil price indices in the indices system.

There are two main future price indices for petroleum: the WTI and the Brent Crude. West Texas Intermediate (WTI), also known as Texas light sweet, is a grade of crude oil used as a benchmark in oil pricing. This grade is described as light because of its relatively low density, and sweet because of its low sulfur content. It is the underlying commodity of Chicago Mercantile Exchange's oil futures contracts. The price of WTI is often referenced in news reports on oil prices, alongside the price of Brent crude from the North Sea. Other important oil markers include the Dubai Crude, Oman Crude, and the OPEC Reference Basket. The WTI is lighter and sweeter than Brent, and considerably lighter and sweeter than Dubai or Oman.

Brent Crude is a major trading classification of sweet light crude oil that serves as a major benchmark price for purchases of oil worldwide. Brent Crude is sourced from the North Sea, and comprises Brent Blend, Forties Blend, Oseberg and Ekofisk crudes (also known as the BFOE Quotation). The Brent Crude oil marker is also known as Brent Blend, London Brent and Brent petroleum. Originally Brent Crude was produced from the Brent oilfield. The name "Brent" comes from the naming policy of Shell UK Exploration and Production, operating on behalf of ExxonMobil and Royal Dutch Shell, which originally named all of its fields after birds (in this case the Brent Goose). But it is also an acronym for the formation layers of the oil field: Broom, Rannoch, Etive, Ness and Tarbert. Petroleum production from Europe, Africa and the Middle East flowing west tends to be priced relative to this oil, i.e. it forms a benchmark. Brent is the leading global price benchmark for Atlantic basin crude oils. It is used to price two thirds of the world's internationally traded crude oil supplies.

Tab. 5-3 Spot price indicators of oil

Kind of oil	Indicator	Dimension
Crude Oil	Cushing, OK WTI Spot Price FOB	Dollars per Barrel
	Europe Brent Spot Price FOB	Dollars per Barrel
	Arab Light Crude Oil Price FOB	Dollars per Barrel
Conventional Gasoline	New York Harbor Conventional Gasoline Regular Spot Price FOB	Dollars per Gallon
	U.S. Gulf Coast Conventional Gasoline Regular Spot Price FOB	Dollars per Gallon
RBOB Regular Gasoline	Los Angeles Reformulated RBOB Regular Gasoline Spot Price	Dollars per Gallon
No. 2 Heating Oil	New York Harbor No. 2 Heating Oil Spot Price FOB	Dollars per Gallon
Ultra-Low-Sulfur No. 2 Diesel Fuel	New York Harbor Ultra-Low Sulfur No 2 Diesel Spot Price	Dollars per Gallon
	U.S. Gulf Coast Ultra-Low Sulfur No 2 Diesel Spot Price	Dollars per Gallon
	Los Angeles, CA Ultra-Low Sulfur CARB Diesel Spot Price	Dollars per Gallon
Kerosene-Type Jet Fuel	U.S. Gulf Coast Kerosene-Type Jet Fuel Spot Price FOB	Dollars per Gallon
Propane	Mont Belvieu, TX Propane Spot Price FOB	Dollars per Gallon

The other well-known classifications (also called references or benchmarks) are the OPEC Reference Basket, Dubai Crude and Oman Crude. All of them provide their price indicators to their customers. These price indicators of petroleum can be divided into two parts: spot price and future price. Table 5-3 gives some spot price indicators.

Intercontinental Exchange (ICE) and New York Mercantile Exchange (NYMEX) are the leading networks of regulated exchanges and clearinghouses for financial and commodity markets. Oil market is one of their most concern areas. Future price indices are their products made from spot price indicators of petroleum. Table 5-4 gives some products of future oil price indicators they provide.

Tab. 5-4 Some indicator products of oil future price[53]

ICE	NYMEX
Brent Crude	Crude Oil Futures
WTI Crude	Natural Gas (Henry Hub) Physical Futures
Gasoil	NY Harbor ULSD Futures
Low Sulphur Gasoil	Natural Gas European Options
RBOB	RBOB Gasoline Physical Futures
180 Cst Singapore	Henry Hub Penultimate NP Futures
Dubai 1st Line	Henry Hub Swap Futures
Brent 1st Line	Brent Crude Oil Financial Futures
Arab Light Crude Oil Price	Crude Oil Options

For table 5-4, every product includes several indices for business. Fig. 5-3 gives a sample of the trend curve for Cushing, OK Crude Oil Future Contract 1. The oil price fluctuation is very significant. Recent price of oil is almost 5 times than Jan. 1999.

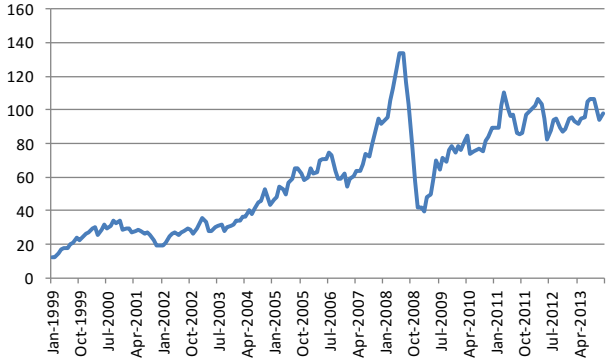


Fig. 5-3 The curve for Cushing, OK Crude Oil Future Contract 1(Jan. 1999-Dec. 2013)[54]

Although there are many indicators for oil price, the biggest and most direct effective factors are ship fuel prices for maritime transport company benefits. In the maritime transport industry, another type of classification is used for fuel oils: ①IFO 380 - Intermediate fuel oil with a maximum viscosity of 380 Centistokes (<3.5% sulphur); ②IFO 180 - Intermediate fuel oil with a maximum viscosity of 180 Centistokes (<3.5% sulphur); ③MDO - Marine diesel oil; ④MGO -

[53] Data source:http://www.cmegroup.com/trading/energy/
[54] Data source: http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rclc1&f=m

Marine gasoil.

Tab. 5-5 Bunker price at some ports on Feb.1 2014[55]

Area	Port	IFO180	IFO380	MGO	MDO
North Euro	Antwerp	n/a	583	n/a	613
	Hamburg	n/a	608	n/a	638
	Le Havre	n/a	598	n/a	630
	Lisbon	n/a	630	n/a	665
	Rotterdam	n/a	584	n/a	613
	Saint Petersburg	n/a	430	n/a	450
South Euro	Istanbul	660	630	970	n/a
	Malta	650	620	925	n/a
	Perama	658	628	928	n/a
	Venice	n/a	643	958	n/a
North America	Houston	710	615	n/a	990
	Los Angeles	675	640	n/a	1045
	Montreal	675	645	n/a	1010
	New York	663	623	n/a	995
	Oakland	680	645	n/a	1055
	Seattle	705	665	n/a	1055
South America	Callao	757	675	n/a	1265
	Coronel	795	705	n/a	1386
	Panama Canal	705	632	n/a	1025
	Rio De Janeiro	651	627	n/a	1015
	San Antonio	787	692	n/a	1378
Asia	Busan	n/a	662	950	940
	Colombo	n/a	723	1160	n/a
	Ho Chi Minh City	n/a	705	996	966
	Hong Kong	n/a	631	925	915
	Kaohsiung	n/a	668	987	972
	Manila	n/a	687	1158	n/a
	Shanghai	n/a	655	1051	n/a
	Singapore	n/a	622	895	885
	Tokyo	n/a	665	n/a	910
Middle East and Africa	Dammam	660	655	1005	n/a
	Fujairah	680	635	1020	n/a
	Jeddah	710	690	1080	n/a
	Kuwait	n/a	n/a	1036	n/a
	Port Said	650	n/a	n/a	910
	Ras Tanura	660	655	1005	n/a

[55] Data source: http://navigatemag.ru/bunker/

Fuel purchase directly affects cost and profit of shipping company, so it is very important to grasp the fuel prices accurately at every port on the route. In order to attract the shipping company berthing their vessel in port, every port authority publish various fuel prices daily like as table 5-5.

MDO and IFO 380 are more popular in maritime transport market. Rotterdam is the biggest port in Europe and Singapore is the busiest port in Asia. So the 380 Singapore, 380 Rotterdam, MDO Singapore, MDO Rotterdam are chosen as spot price indicators of bunker. WTI future and Brent future are chosen as future price indicators of petroleum.

⑤Fleet capacity indicators

CRSL induces three categories of fleet supply capacity index: increasing capacity, existing capacity and reducing capacity. Increasing capacity appears as contracting, order, deliver and other addition capacities. Reducing capacity appears as demolition, losses and removals capacities.

For maritime transport market, order capacity means the future capacity of fleet, existing capacity means present provide ability of fleet. For different type of vessel, the indicators list in table 5-6 can be used in the PIGMT.

Tab. 5-6 Indicators for fleet capacity

Orderbook capacity by ship type	Bulk carrier
	Tanker
	Container
Present capacity by ship type	Bulk carrier
	Tanker
	Container

⑶Confirmed indicator system

Facing 117 indicators above, we chose 30 as the indicator system of the PIGMT with the Delphi method. There is the questionnaire for three round investigation in Appendix C.

After choosing indicators from relative factors of maritime transport market, the principle of IEI can be used. According to the analysis in chapter 4, the indicators chosen above can be put in leading, coincident, and lagging indicator groups.

①Leading indicators

For PIGMT, leading indicators include three parts: trade value, future freight rate and future cost of fuel. The chosen indicators are listed in table 5-7.

Tab. 5-7 Leading indicators of the PIGMT

Character	Indicator	Dimension
Trade Value	Grain	Million US Dollars
	Iron ore	
	Coal	
	Crude oil	
	Products	
Future Freight Agreement	Dry FFA	/
	Tanker FFA	/
	Liner FFA	/
Future Price of Crude Oil	Brent*	US Dollars/barrel
	WTI*	US Dollars/barrel

②Coincident indicators

For the PIGMT, coincident indicators also include three parts: transport volume, freight rate and spot price of fuel. The chosen indicators are listed in table 5-8.

Tab. 5-8 Coincident indicators of the PIGMT

Character	Indicator	Dimension
Transport Volume	Grain	Million Tons
	Iron ore	
	Coal	
	Crude oil	
	Container	Million TEU
Freight Rate	BDI	/
	BCI	/
	BPI	/
	BDTI	/
	CTRI	/
Price of Fuel	380 Singapore*	US Dollars/ton
	380 Rotterdam*	US Dollars/ton
	MDO Singapore*	US Dollars/ton
	MDO Rotterdam*	US Dollars/ton

③Lagging indicators

For the PIGMT, lagging indicators include two parts: new building orderbook capacity and present capacity by ship type. The chosen indicators are listed in table 5-9.

Tab. 5-9 Lagging indicators of the PIGMT

Character	Indicator	Dimension
Orderbook capacity	Bulk	Million tons
	Tanker	Million tons
	Container	Million TEUs
Present capacity	Bulk*	Million tons
	Tanker*	Million tons
	Container*	Million TEUs

④Summarize briefly

After analyzing the indicators of macro economy, international trade, maritime freight rate and maritime transport capacity, according to the demand of calculation for prosperity index, 11 trade indicators, 8 freight indicators, 5 maritime transport volume indicators, 6 maritime transport capacity indicators, total 30 indicators were selected as the members of prosperity index of global maritime transport. 8 of them are dimensionless. Others have 7 kinds of various dimensions.

Of particular note is, in these 30 indicators, 21 positive and 9 negative correlation with the PIGMT. These 9 negative indicators are marked with * at end of their name in the table 5-7, 5-8

and 5-9. The indicator structure of the PIGMT is as in Fig. 5-4 following Fig. 5-2. Of course, this system was decided by Delphi Method. The questionnaire is listed in appendix C.

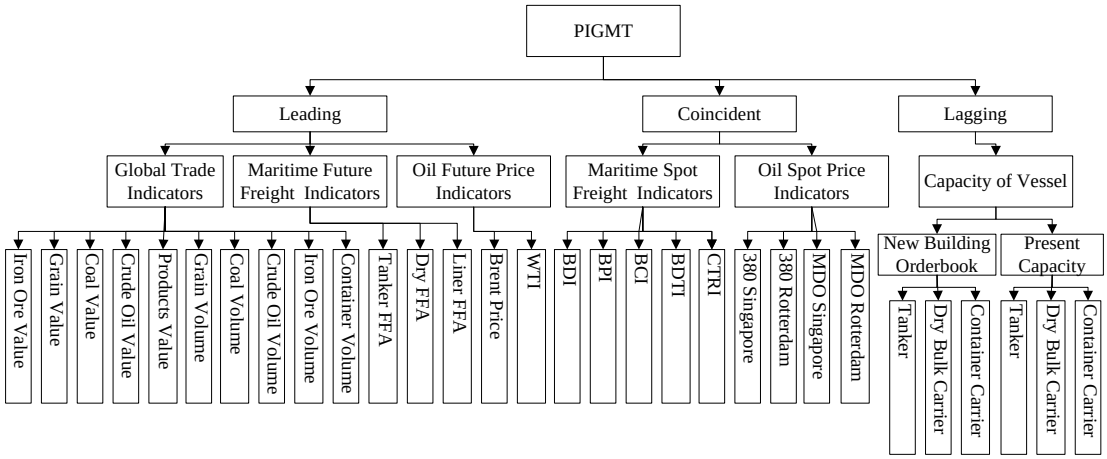


Fig. 5-4 The indicator theoretical structure of the PIGMT

5.2 Calculation method

The aim of this section is to set up the calculation model for the PIGMT. To calculate the value of the PIGMT, some hypothesis are needed.

5.2.1 Presumption

There are seven presumptions as follows for the PIGMT:

⑴The PIGMT issued monthly

The reasons of the PIGMT issued monthly are three points: ①From characteristic of prosperity index, they only characterize the situation of macro economy or industry economy, not for pricing. So most of prosperity index is issued monthly, seasonally and annually. ②From the side of investment on vessels or shipping companies, it is not necessary for investors to know the prosperity index daily or weekly. A continuous monthly prosperity index is enough. ③Some original data like as value of global international trade is issued only monthly.

⑵If related to money, the indicator is denominated in US dollar

There are 11 indicators whose dimension is related to money (read table 5-7, 5-8 and 5-9). They already are denominated in US dollar fortunately. This hypothesis is for index adjustment when non US dollar denominated indicator is chosen.

⑶Regardless of the fluctuation of exchange rate;

This hypothesis is related to ⑵. If a non US dollar indicator be changed to be denominated in US dollar, the nominal exchange rate can be used.

⑷Regardless of changes in the value of US dollar

This hypothesis is related to ⑵ and ⑶. If any US dollar indicator be chosen, only the current value of US dollar is used because the PIGMT is also current.

⑸If the chosen indicator issued monthly, the data will be used regardless of its method

There are 10 indicators issued monthly in table 5-7 and 5-8. They are in trade group and transport volume group. In addition to a number of indicators both daily and weekly data, they also have monthly data, for example BDI, BCI, BPI, etc. If the publisher of indicator provides monthly data, this data will be used, regardless of its conversion method.

⑹If the chosen indicator is issued weekly or daily, the data will be changed monthly from the arithmetic mean value of period real issued data

Some indicators are issued daily and weekly. Their publishers do not provider monthly data for them like as the indicators in FFA and price of fuel groups. In this situation, the daily data or weekly data will be converted to monthly data by the arithmetic average method.

⑺The PIGMT is dimensionless

Finally, the PIGMT must be dimensionless as the chosen indicators have different dimensions. Actually, most of prosperity indices are dimensionless as they are also composite indices. For this reason, it is necessary for every indicator to be removed with dimension. The dimensionless method will be discussed in section 5.2.2.

5.2.2 Algorithm

For calculation of the PIGMT, three points are important: dimensionless, weights of indicators and calculation formula of the PIGMT.

⑴Calculation for weight

Fig. 5-4 gives the indicator theoretical framework of the PIGMT. But this framework makes the weight calculation difficult as comparing is intricate. If changing the indicator framework to Fig. 5-5, it is easier to compare the indicators using weighting method of AHP.

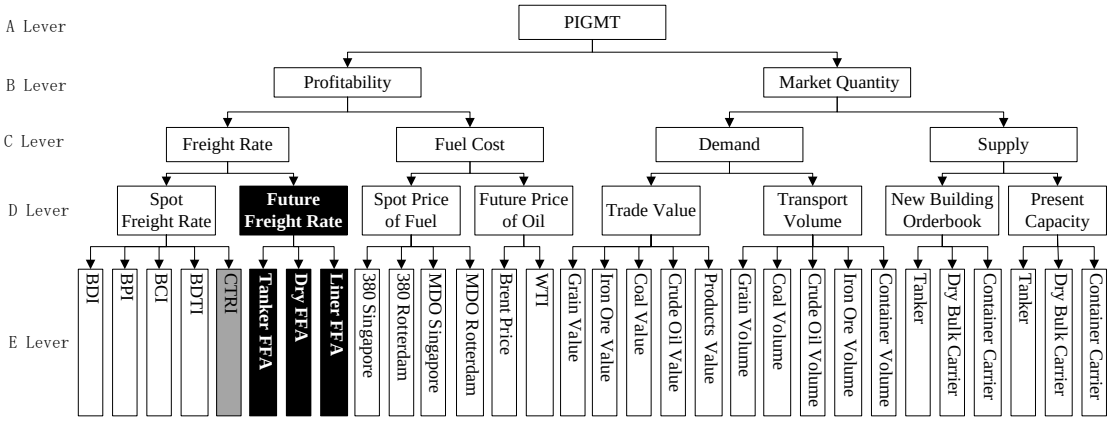


Fig. 5-5 The indicator market structure of the PIGMT

This indicator system has five hierarchies. FFA trade started with the BFI at the end of 1980. To push the FFA trade, Baltic Exchange changed the BFI to the BDI in 2000. 5 years later, the trade of dry FFA became more frequent. Following the dry FFA, the tanker FFA (wet FFA) also began attracting attention in 2006. These situations caused the dry and wet FFA data incomplete before 2006. Furtherly, as the global liner freight index does not appear until now, there is no suitable data for the liner FFA. Therefore, the indicators of the future freight rate were filled with dark background in Fig. 5-3. When calculating the PIGMT next, these indicators are not included.

In the spot freight rate, compared with the BDI, the BCI, the BPI and the BDTI, CTRI is not suitable as it is time charter rate but liner freight rate for same reason. So it is marked grey background in Fig. 5-5. It is one of the reasons that the DCFI will be developed in chapter 6.

The weights of lower lever indicators to higher lever indicator were given by industry experts with questionnaire (see appendix D).

$$w_i = \prod_{l=1}^{e} w_{il} \tag{5-21}$$

In formula 5-21,

w_i —weight of no. i indicator

l —lever number of indicator

e —less 1 than amount of levers in the indicator framework

w_{il} —weight of the indicator in l lever to upper lever, given by industry counselors

For y indicator, if there are x indicators in next down lever, then to y indicator, the sum of weights of indicators in the lever must be 1.

That is: $\sum_{x=1}^{k} w_x = 1$

According to the regulation above, the w_i for every indicator can be calculated.

There are two weights setting method: static and dynamic. Static weight means that same weight will be used in all period of calculation. Dynamic weight means that the weight will be changed in the period of calculation according to some regulations. In this situation, the PIGMT will be calculated with static weight first. If the result can be accepted, then the dynamic weight will be tested.

⑵Dimensionless

For 7th hypothesis above, it is necessary to remove the dimension for all of indicators. As there are 21 positive indicators and 9 negative indicators, the dimensionless methods are different.

①For positive indicator

Formula 5-2 can be used to remove the dimension for positive indicator.

$$I_{pt} = \frac{I_t}{I_0} \tag{5-22}$$

In formula 5-22,

I_{pt} —dimensionless value of positive indicator at t time

I_t —value of indicator at t time

I_0 —initial value of indicator

②For negative indicator

Formula 5-23 can be used to remove the dimension for negative indicator.

$$I_{nt} = \frac{I_0}{I_t} \tag{5-23}$$

I_{nt} —dimensionless value of negative indicator at t time

⑶Calculation formula of PIGMT

Based on research above, the calculation formula of the PIGMT can be listed as in formula 5-24.

$$PIGMT_t = \sum_{i=1}^{p} 100 \times w_i \times \frac{I_{it}}{I_{i0}} + \sum_{j=1}^{n} 100 \times w_j \times \frac{I_{j0}}{I_{jt}} \tag{5-24}$$

In formula 5-4,

$PIGMT_t$ —value of prosperity index of global maritime transport at t time

i —serial number of positive indicator

p —amount of positive indicators

w_i —weight of no. i positive indicator

I_{i0} —initial value of no. i positive indicator

I_{it} —value of no. i positive indicator at t time

j —serial number of negative indicator

n —amount of positive indicators

w_j —weight of no. j negative indicator

I_{j0} —original value of no. j negative indicator

I_{jt} —value of no. j negative indicator at t time

5.2.3 Correlation analysis for some indicators

Preserve the independence of each indicator is an important duty when establishing index system. In the index system shown in Fig. 5-4, some indicators looked like that they have close correlations, for trade value and transport volume of goods, spot price and future price of oil, etc. The correlation analysis for those indicators are as follows.

⑴ Correlation of the trade value of product and the transport volume of container

With the monthly data of the trade value of product and the transport volume of container from Jan. 2000 to Dec.2015, the Fig. 5-6 can be made. Meanwhile, the R^2 is 0.1302.

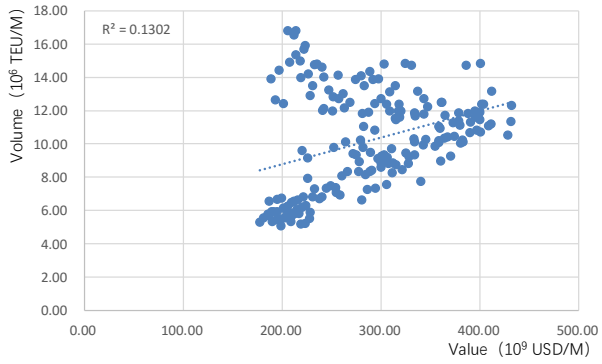


Fig. 5-6 Correlation of the trade value and the transport volume of container

(2) Correlation of the trade value of crude oil and the transport volume of crude oil

With the monthly data of the trade value of crude oil and the transport volume of crude oil from Jan. 2000 to Dec.2015, the Fig. 5-7 can be made. Meanwhile, the R^2 is 0.0325.

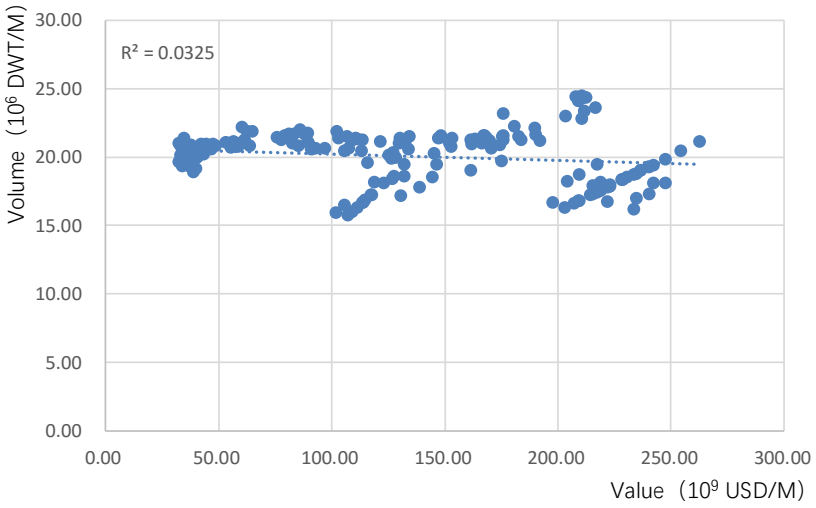


Fig. 5-7 Correlation of the trade value and the transport volume of crude oil

(3) Correlation of the trade value of and the transport volume of coal

With the monthly data of the trade value of crude oil and the transport volume of coal from Jan. 2000 to Dec.2015, the Fig. 5-8 can be made. Meanwhile, the R^2 is 0.1756.

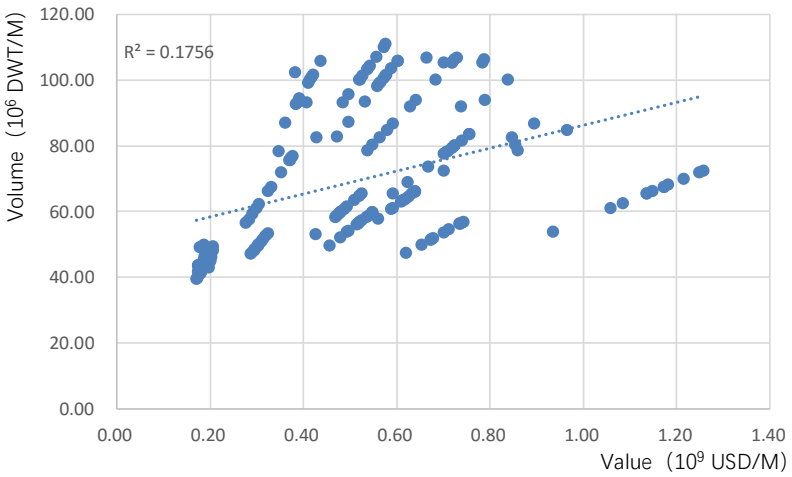


Fig. 5-8 Correlation of the trade value and the transport volume of coal

From Fig. 5-6 to Fig. 5-8, all of R^2 are smaller than 0.2. Therefore, the trade value and transport volume in same month are very lower correlation. In fact, most of sales contract order the delivery date in next one or more month. So the indicators for trade value and transport volume can be used in the index system.

(4) Correlation of spot price and future price of oil

With the monthly data of Rotterdam spot price of 380cst and WTI from Jan. 2000 to Dec.2015, the Fig. 5-9 can be made. Meanwhile, the R^2 is 0.9053. This shows the spot price and

future price of oil have strong correlation.

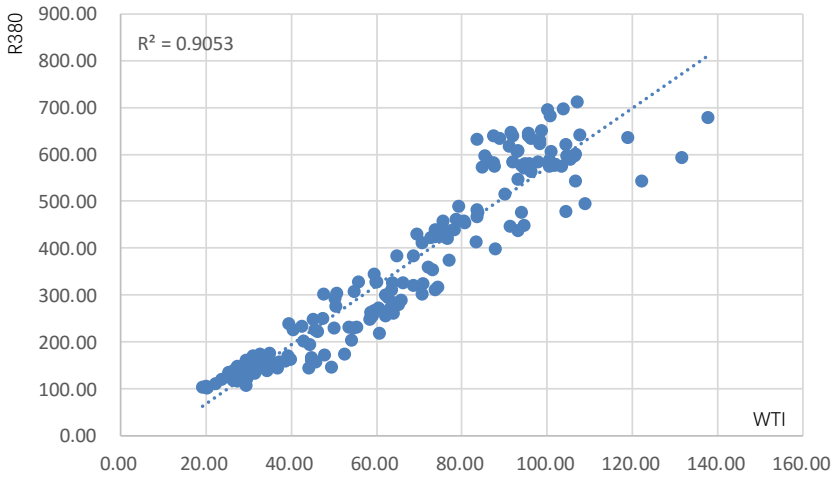


Fig. 5-9 Correlation of R-380cst and WTI

But in some special time, there are still some asynchronous situations. From Oct. 2008 to Feb.2009, the time difference of R380 and WTI almost is 2 or 3 month. (see Fig. 5-10)

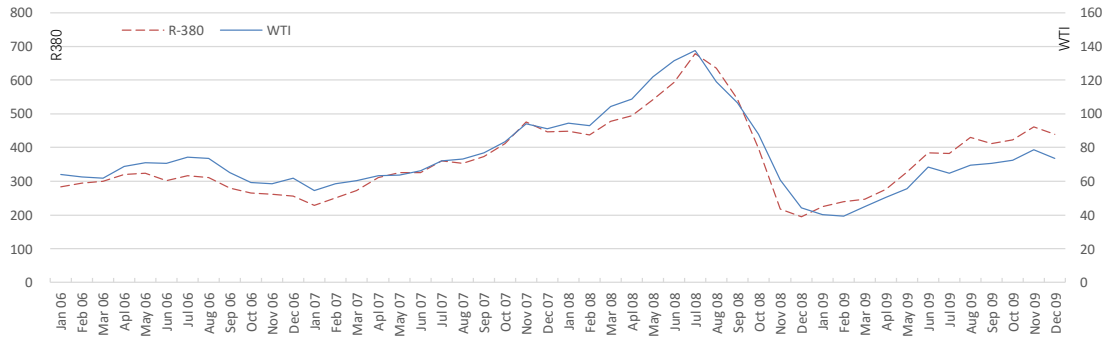


Fig. 5-10 R-380cst and WTI (Jan. 2006-Dec. 2010)

As the PIGMT is a monthly index, to cover this asynchronous, the R-380 and WTI must be retained.

5.2.4 Results of the PIGMT

Based on formula 5-4, the value of the PIGMT at t time can be calculated. Middle value of the PIGMT is 100. Different value of the PIGMT gives different situation of global maritime transport market like in table 5-10. To be understood easily, the different color can be used.

Tab. 5-10 Color for prosperity of global maritime transport market

Value of PIGMT	Situation of global maritime transport market	Color for Prosperity
180＜PIGMT≤200	Heat death	
160＜PIGMT≤180	Overheated	
140＜PIGMT≤160	Scalding	
120＜PIGMT≤140	Hot	
100＜PIGMT≤120	Warm	

80＜PIGMT≤100	Cool	
60＜PIGMT≤80	Cold	
40＜PIGMT≤60	Freeze	
20＜PIGMT≤40	Iced	
0≤PIGMT≤20	Winterkill	

5.3 Process of Calculation

The process of calculation for the PIGMT is in Fig. 5-11.

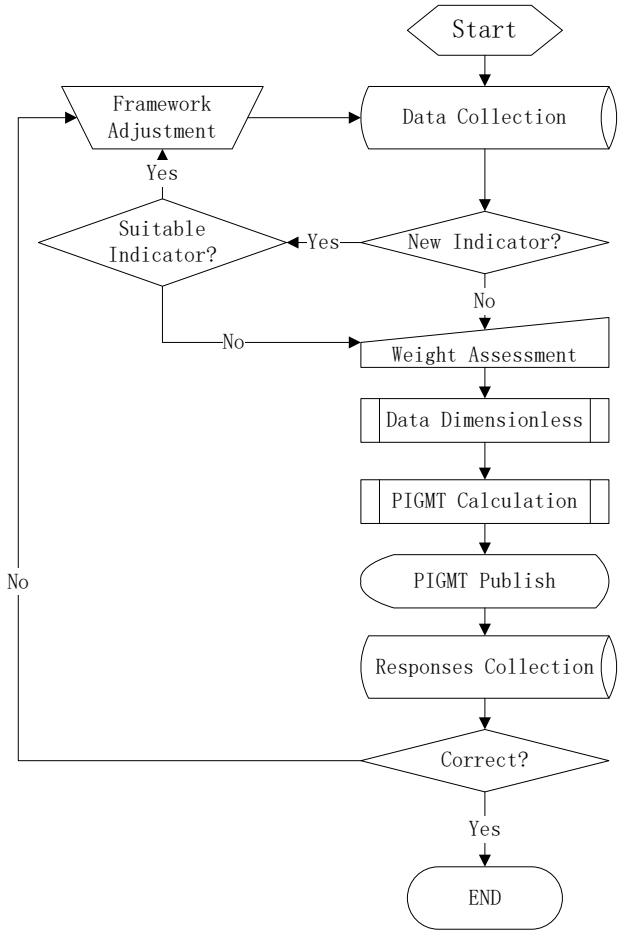


Fig. 5-11 Calculation process for the PIGMT

Step 1: data collection.

The designed calculation method for PIGMT depends on existing indicators. For total 30 indicators, the data sources and types are different. The work of data collection is boring and requires patience. Specially for daily data, as it is needed to transfer to monthly data, so the amount of working days in the month must be paid attention to.

Step2: indicator system adjustment.

Further, as time goes on, new indicators appear continuously. So data collection is not only for chosen indicators but also for new indicators if which are more suitable.

Step 3: weight assessment.

Weight assessment depends on the opinion of experts and counselors. This is the most subjective part in whole algorithm. Therefore, this requires experts and counselors have rich experience and good reputation. Meanwhile, as the global maritime transport market is so huge and complex that no one could know everything in this market, different opinions from various experts and counselors are needed.

Step 4: data dimensionless.

According to the positive and negative characters, put the data into the formula 5-22, 5-23 respectively, the dimensionless data is gotten.

Step 5: value calculation.

Put data into formula 5-24, the value of the PIGMT is gotten[56].

Step 6: the PIGMT publish.

According to table 5-10, the situation of global maritime transport market can be published.

Step 7: responses collection.

Collect the responses from the market, if the result is correct, the process end; if the result is not correct, the framework of the PIGMT should be changed. Then go through the process of calculation again until the response is correct.

5.4 Application of the algorithm of the PIGMT

This section will show the all process for the calculation of the PIGMT. It includes original data acquisition to the starting point establishment, intermediate results calculation and test, and the practical application finally.

5.4.1 Data Source

After searching the data of the indicators listed in Fig.5-3, we found most of the data sources can supply their data from 1999-2012. But the FFA of the Baltic Exchange just have their data after 2006 as some of the business just started in that time. In order to maintain the consistency of the data, all of the FFA indicators are canceled. Next calculation will depend on the indicators listed in table 5-11.

Tab. 5-11 Data sources for selected indicators

No.	Indicator	Dimension	Data source	Website
X1	Order of dry bulk	Million tons	Clarkson Research Service Ltd.	http://www.crsl.com/
X2	Order of tanker	Million tons		
X3	Order of Container	Million TEU		
X4	Capacity of dry bulk	Million tons		
X5	Capacity of tanker	Million tons		
X6	Capacity of box vessel	Million TEU		
X7	Value of grain	Million US$	World Trade Organization Statistics Database	http://stat.wto.org/Home/WSDBHome.aspx?Language=
X8	Value of iron ore	Million US$		
X9	Value of coal	Million US$		
X10	Value of crued oil	Million US$		

[56] The PIGMT can be calculated with Microsoft Excel.

X11	Value of Products	Million US$		
X12	Volume of grain	Million tons	UNCTAD Stat	http://unctadstat.unctad.org/
X13	Volume of iron ore	Million tons		
X14	Volume of coal	Million tons		
X15	Volume of crude oil	Million bpd		
X16	Volume of products	Million TEU		
X17	Monthly average of BCI	/	Baltic Exchange	www.balticexchange.com
X18	Monthly average of BPI	/		
X19	Monthly average of BDI	/		
X20	Monthly average of BDTI	/		
X21	Monthly average of CTRI	/		
X22	380CST Singapore	USD$/ton	Clarkson Research Service Ltd.	http://www.crsl.com/
X23	380CST Rotterdam	USD$/ton		
X24	MDO Singapore	USD$/ton		
X25	MDO Rotterdam	USD$/ton		
X26	Monthly Brent price	USD$/bbl	Intercontinental Exchange, Inc.	https://www.theice.com/marketdata/
X27	Monthly WTI price	USD$/bbl)	US Energy Information Administration	http://www.eia.gov/

As the original data of X17 to X27 are issued daily, they must be processed to be monthly data first. The results of processed data are listed in Appendix A.

5.4.2 Test for algorithm

The work for data process was hard, especially to make the daily data to be monthly data. Appendix A just shows the monthly data because of the huge original daily data. Put the data from Jan. 2000 to December 2009 in Appendix A to the model in section 5.2, after calculating many times, a set of reasonable result can be listed as in table 5-12. The initial 100 point was set in January 2006. Meanwhile, the test curve is shown in Fig. 5-12.

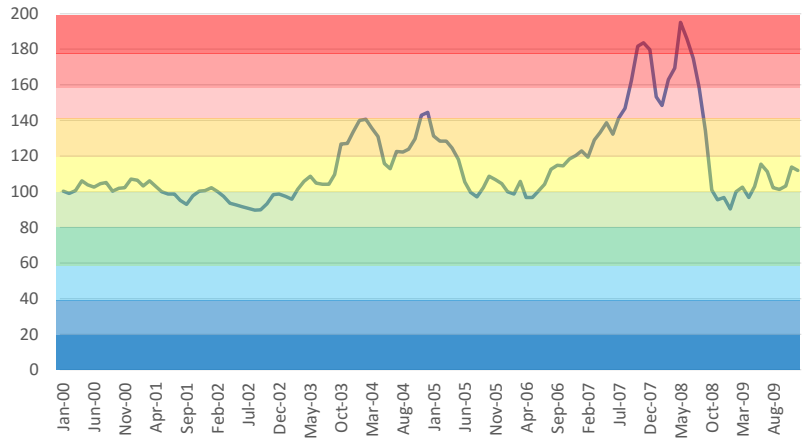


Fig. 5-12 Test result curve for the PIGMT (Jan. 2000—Dec. 2009)

Tab. 5-12 the test calculate result for the PIGMT

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Jan.	100.71	106.72	102.62	97.74	140.40	131.64	100.00	123.30	153.79	90.85
Feb.	99.36	103.70	100.18	96.30	140.97	128.95	99.22	119.70	148.86	100.38
Mar.	101.04	106.38	97.70	101.81	136.33	128.75	106.42	129.44	163.48	103.11
Apr.	106.46	103.32	93.99	106.14	131.34	125.08	97.25	133.82	170.05	97.13
May	104.33	100.40	92.93	108.98	116.34	118.47	96.80	139.29	195.60	103.27
Jun.	103.03	98.93	92.03	105.21	113.32	105.94	101.07	132.77	186.49	116.19
Jul.	104.81	99.01	91.08	104.58	123.08	100.10	104.78	141.91	175.41	111.91
Aug.	105.36	95.36	90.17	104.57	122.94	97.51	112.99	147.46	159.25	102.88
Sep.	100.57	93.31	90.10	110.09	124.41	102.59	115.21	162.77	134.97	101.79
Oct.	102.10	97.97	93.56	127.10	130.33	109.29	115.05	182.12	101.77	103.71
Nov.	102.49	100.59	98.61	127.66	143.44	107.24	118.82	184.19	95.98	114.48
Dec.	107.50	101.12	99.03	134.12	145.11	104.98	120.81	180.40	97.55	112.63

The curve in Fig. 5-11 indicated the global maritime transport market was warm and warmer in most of the time from January 2005 to February 2007, but overheated in fall and winter 2007 and in spring and summer 2008. As the impact of the financial crisis 2008, the global maritime transport market went to cold in six months. At that period, the price of oil also fell rapidly, the lowest point was just 90.85 in January 2009. But it just was cool, far from freezing even iced.

To inspect the accuracy of calculation method of PIGMT, the profit data (Jan. 2005- Dec. 2009) of a famous Chinese state owned large shipping group company was processed as Fig.5-13. Compared with Fig.5-12, the shape of curve in Fig.5-13 was quite similar if 2 singular points (a, b) be cancelled. These 2 points happened at the end months in these two years as there accounting process.

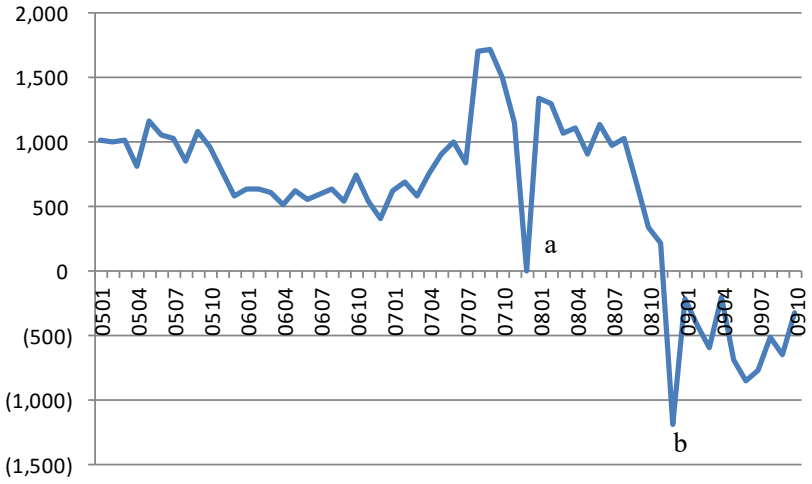


Fig. 5-13 Profit index of X shipping group (Jan. 2005- Oct. 2009)

Therefore, although the algorithm still need to be modified further, the PIGMT already almost described the real situation of global maritime transport market rightly.

5.4.3 Tracking analysis

Further calculation is to collect more 72 months data and to calculate the PIGMT in the periods. Table 5-11 gives the calculation results for the PIGMT.

Tab. 5-11 Calculate result for the PIGMT

Year	2009	2010	2011	2012	2013	2014	2015
Jan.	90.85	113.26	94.97	85.52	95.91	105.80	83.24
Feb.	100.38	105.22	90.97	78.48	95.94	100.43	82.82
Mar.	103.11	112.73	100.71	104.13	96.15	106.00	83.43
Apr.	97.13	111.42	97.20	102.96	98.29	99.69	84.02
May	103.27	119.79	98.18	102.60	97.51	99.03	85.20
Jun	116.19	114.68	97.45	97.23	97.02	97.63	88.36
Jul	111.91	102.72	95.76	99.49	100.37	98.18	89.63
Aug	102.88	108.10	97.68	99.09	99.14	99.78	87.33
Sep	101.79	111.72	100.63	97.02	106.61	101.18	85.46
Oct	103.71	110.18	101.15	99.03	106.63	100.65	81.15
Nov	114.48	104.65	98.96	100.19	101.37	100.67	76.94
Dec	112.63	104.62	101.26	101.33	114.48	93.35	78.14

Fig.5-14 gives the curve for 16 years (192 months). It shows that the most terrible situation did not happen in the end of 2008 and beginning of 2009. After 6 months, the global maritime transport market became little warm as the governments launched aggressive monetary policy to slow the economy recession. Effect of these policy lasted for about 2~3 years. With the sustained downturn of the global economy and the durative high price of crude oil, since January 2012, the global maritime transport market became more and more cold. Since middle of 2013, with the price drop of crude oil, the market situation became cool from cold although the freight rate was keeping lower lever.

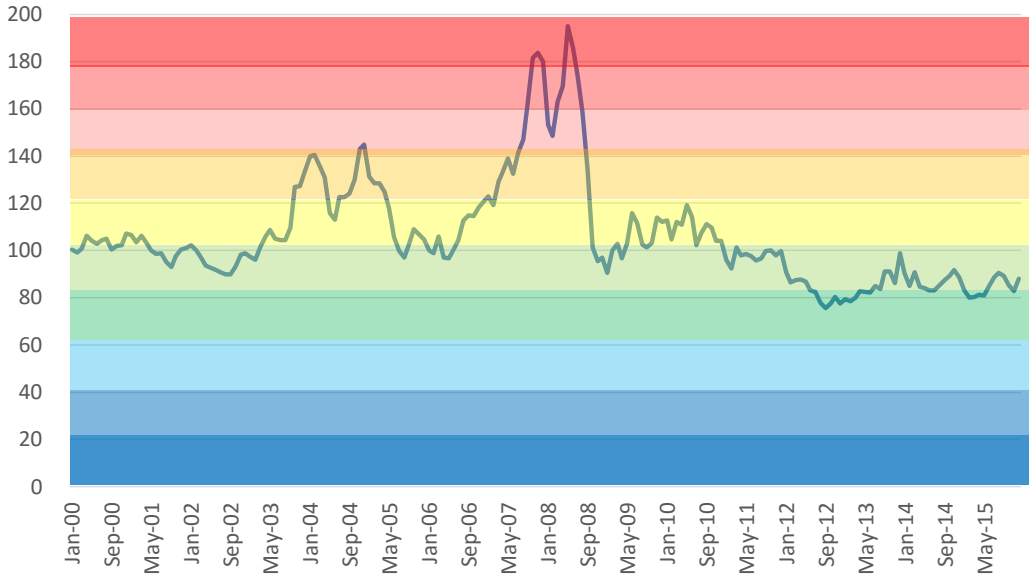


Fig. 5-14 The PIGMT Curve (Jan. 2000—Dec. 2015)

From the Fig.5-14, it is easy to find that the global maritime transport market entered cold situation twice in September 2012 and February 2015. But the reasons were different. In 2012, the main reason was the higher price of fuel. In 2015, the main reason was the lower freight rate. In 2015, lower price of fuel reduced the pressure on the shoulder of carriers although the freight rate went to a lower trend (for example, the BDI was lower than 400 at the end of 2015 and beginning of 2016).

5.5 The PIGMT with dynamic weight

The PIGMT in section 5.4 was calculated with fixed weight for 16 years. It is easy to be questioned as the economy environment of global maritime transport market has changed greatly in this period. The importance of various factors in this index system cannot be fixed. Therefore, the dynamic weight will be tested for the prosperity index of global maritime index in this section.

5.5.1 The regulation for dynamic weight

There are many kinds of dynamic weight setting methods, like time series dynamic weight, fuzzy dynamic weight, grey dynamic weight and maximum entropy method, etc.. In this section, the time series dynamic weight will be used because of the data source limitation.

For the method of time series dynamic weight setting, there are sight weight, fixed period weight and variable period weight, etc.. Although the sight weight can give the real result, but it will cause the difficulty of data collection and change the comparability. Actually, business cycle always have its regularity. In one cycle, the fixed weight can be used. In another cycle, the weight can be changed by experts consultation. The global maritime transport market is no exception.

Martin Stopford (2009) described the shipping cycles in section 3.1 of his book. At the end of this section, he summarized that shipping cycles have different components – long, short and seasonal. The long cycle mainly depends on world economy. The seasonal cycle depends on global weather. The most confusing cycle, the short cycle used to extend for 4~6 year in history. Sometimes the market gets stuck in the middle ground between trough and recession. Following his survey, it can be assumed that the global maritime market has one cycle for every five years. In this cycle, the index weight can be assumed constant.

5.5.2 The PIGMT with dynamic weight

For the test calculation of the PIGMT, the collected data starts from Jan. 2000. During Jan. 2000 to Dec. 2015, they are in four cycles: ①Jan. 2000-Dec.2004, ②Jan. 2005-Dec. 2009, ③ Jan. 2010-Dec. 2014 and ④Jan. 2015- Dec.2019. So, the dynamic weight for the different cycle can be set like as shown in table B-30.

With the dynamic weight in table B-30, the dynamic PIGMT can be calculated (see table B-31). The curves of the $PIGMT_s$ and the $PIGMT_d$ (Jan. 2000—Dec. 2015) are shown in Fig. 5-14. Here, the dashed red line shows the static PIGMT ($PIGMT_s$), blue line shows the dynamic PIGMT ($PIGMT_d$).

From the Fig.5-15, it is not so obvious for the difference between the $PIGMT_s$ and the $PIGMT_d$. Before the Jan. 2005, most points of the $PIGMT_s$ are lower than the $PIGMT_d$. After Jan. 2010, most points of the $PIGMT_s$ are higher than the $PIGMT_d$. It is not easy to find the relationship between them.

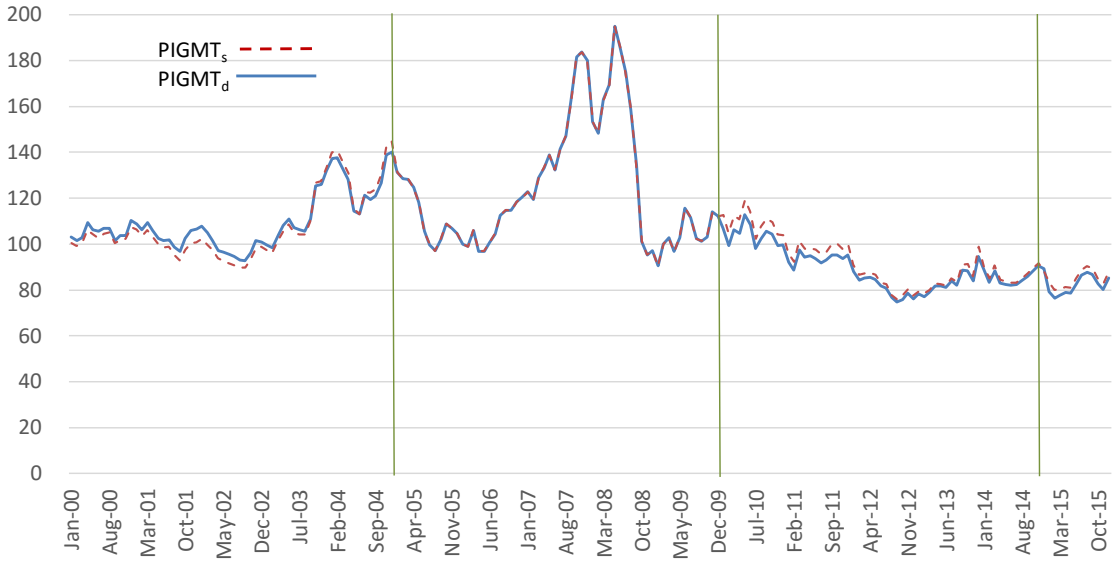


Fig. 5-15 The curves of the $PIGMT_s$ and the $PIGMT_d$ (Jan. 2000—Dec. 2015)

Meanwhile, it is almost correct that the cycle of global maritime transport market is 4~6 years. It is one more evidence for the judgement of Professor Martin Stopford. So for every five years, the weights of the indicators had better to be changed once. If any special thing happens, the period of changing weight can be adjusted in 4-6 years.

Furtherly, the PIGMT with dynamic weights gives better result than with static weights on the view. Therefore, the dynamic weight should be used in the calculation method of the PIMGT. For this reason, we need an experts group for the evaluation of the weight in sometime. Part of the experts group should be fixed.

Chapter 6 The Daily Container Freight Index

Chapter 5 gives the algorithm of the PIGMT. The PIGMT covers three basic parts of the global maritime transport market: bulk, tanker and container liner. As there is no global container freight index now, the CTRI is chosen as the liner freight index. This chapter will try to design an algorithm of the daily container liner freight index based on the data from some e-booking platform in this begging of the era of big data.

6.1 Preliminary

Absolutely different with the tramp market, freight rate of container liner market is quite complex. Table 6-1 gives the outline of the structure of container liner freight rate.

Tab. 6-1 The structure of container liner freight rate

according to		
attribute of cost	Fixed cost	Changeable cost
	Basic freight	Surcharge
loading status	Full container load	Less than container load
	FCL rate	LCL rate
carrier	liner company	NVOCC
	Liner rate	NVOCC rate

In this situation, the important thing is to choose the correct freight rate as the basic data of the index.

6.1.1 Liner freight scheme

In global container liner market, liner companies used to sell the shipping spaces to freight forwarders instead of shippers directly, and hence the pricing mechanism/scheme for the spaces of liner freights is a multi-level structure (see Fig.6-1). The first level is on the prices for the liner's spaces of freights paid by forwarder j to liner companies i, denoted by f_{ij}. Here we also index forwarder j as (i, j) or ij to emphasize his or her relationship with liner i. The second level is on the prices for forwarder ij's spaces for freights paid from forwarder agent (i,j,k) or shortly ijk to forwarder ij, denoted by f_{ijk}. The third level is the price for the agent's spaces for freights paid from shipper l to forwarder agent ijk, denoted by f_{ijkl}.

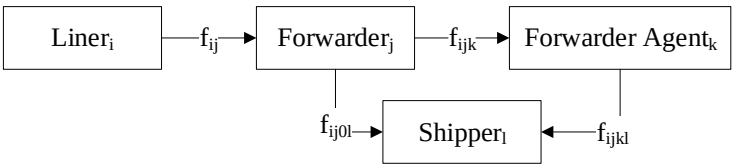


Fig.6-1 The cash flow in liner market

Liner companies used to print their freight lists and sailing schedules in newspapers or business magazines. This kind of freights can be called *nominal freights* and written as f_i. The f_i is seldom to be carried out because most of liners divide and give their shipping spaces to several forwarders in each port. They also give different forwarders, said forwarder j, a wholesale price f_{ij} for the assigned freights where these whole sale prices are different as the shipping spaces

assigned to these forwarders are different. Usually, f_{ij} is smaller than f_i for any forwarder j. Now let us look at the next level where Forwarders provide their booking and document services further to forwarder agents. The unit wholesale price charged from forwarder agents, say agent ijk, is f_{ijk}. At the last stage, most of shippers, said shipper l, contract the transport service directly with forwarder agent ijk at unit price f_{ijkl}, where the contract may include some additional services as follows: moving empty containers from a container yard to shipper's warehouse, loading the goods into a container, moving a heavy container from shipper's warehouse to the port and providing export clearance service, etc. It is not difficult to see that the f_{ijkl} offered by agent ijk to shipper l should be higher than f_{ijk} in theory. But in practice, usually f_{ijkl} is smaller than f_{ijk} due to the intensive freight competition in practical liner forwarder market, where forwarder agents might attract more service revenue if the price offered from this forwarder agent is comparatively lower than his or her payment to forwarders. At some extreme case, this price could be 0 or even negative (see table 6-4).

In this system, although the liner company has an absolute monopoly of special line connecting one port to another (i.e. Far-east to South Africa route of Maersk Line, connecting Shanghai to Durban), the market faced by shippers is still a perfect competition market with sufficient number of forwarder agents with their different freight rates.

6.1.2 Freight index design

As aforementioned, for shipper l, f_{ijkl} is their real marine transport cost f_i and f_{ij}. Therefore shipper l pays more attention to the fluctuations of f_{ijkl} rather than f_i and f_{ij}. Hence in the paper we focus our analysis on container liner freight index derived from the values of f_{ijkl} ..

The data source of the CCFI and the SCFI is from a reporting system under the Ministry of Transport of China. This system requires every liner company or Non-vessel Operating Common Carrier (NVOCC) which has business in the mainland of China to report its container CY-CY[57] freights of main routes to the Shanghai Shipping Exchange (SSE) weekly. The SSE selects out 14 main routes connecting China main ports owned by 19 liners, and uses the freight data (from April 1998) on these selected routes to issue the CCFI. On the other hand, the SSE also selects out 15 main routes connecting from Shanghai port owned by these 19 liners and 17 NVOCCs, and uses the freight data (from October 2009) on these selected routes to issue the SCFI. Recall the shipping prices discussed before. The data source for the CCFI is essentially the prices paid from forwarders to liners, i.e., fi, and the data source of the SCFI is the combination of the prices paid from forwarders to liners, i.e., fi, and the prices paid from forwarder agents to forwarders, i.e. f_{ij}. Meanwhile, the freight data includes not only basic ocean freight but also some additional charges such as the BAF, the EBS, the CAF, the PSS, the WRS, the PCS, the SCS, etc. Note that the THC, the ORC, the AMS charges are not included[58]. This is an evidence that the SCFI and the CCFI are the indices for liners and NVOCCs but not for shippers, at least cannot provide insightful information for shippers.

In the next step, we investigate the details on how the SCFI is designed as an example

[57] CY-CY: Container Yard to Container Yard, a kind service model that liner company provide

[58] BAF-Bunker Adjustment Factor, EBS-Emergency Bunker Surcharge, CAF- Currency Adjustment Factor, PSS-Peak Season Surcharge, WRS-War Risk Surcharge, PCS-Port Congestion Surcharge, THC-Terminal Handling Charge, ORC-Original Receive Charge, AMS-Automatic Manifest System

because the SCFI is calculated with the export freight from Shanghai port same as the data set of two e-booking platforms.

Algorithmically, the SCFI includes 1 comprehensive index and 15 route indices. Each route index corresponds to a major route and has unit as USD/TEU. They are calculated by arithmetic average with the freights of particular routes which is provided by different carriers. The comprehensive index is calculated by assigning every routes a weight and performing the weight average over the routes indices, where the weight is calculated with a base period set at Oct. 16, 2009, and the weights of route indices of the SCFI are static. Therefore, how to determine the weights for the routes is the key step in carrying out the indices.

For many shippers and freight forwarders, a suitable container liner freight index is very helpful when developing their business. But the week issuance and territorial nature becomes the critical disadvantage of the shippers' use of the SCFI, since container liner transportation is a global and daily business. This is also a main challenge of designing a new container liner freight index. The main contribution of this paper is to propose a way to comprehensively use the daily changing data from many shipping e-booking platforms to construct a freight index to characterize the dynamics in the global container liner transportation system.

6.1.3 Analysis for data source of e-booking platform

Before going to the details in index designing, we give some preliminary description on how the e-booking platforms looks like. E-booking platforms can be divided into three types according to the types of freight providers. First is liner's e-booking platform, like *eshippinggateway.com* and *inttra.com*. Second is NVOCC's e-booking platform, like *sinotransbooking.com* and *cntrans.cn*. Third is information exchange platforms based on forwarder agent clubs like *365wuliu.com, dayinghome.com*. This kind of forwarder agent clubs own hundreds of members in big port cities. The platforms enable members to exchange shipping spaces, freights and clients information online and offline with each other, which implies that the freight data of this platform is about the prices paid by shipper directly to forwarder agents, i.e., f_{ijkl} or the prices paid by forwarder agents to forwarders, i.e. f_{ijk}; instead of the information on the prices paid by forwarders to liners (f_{ij}) or the prices charged by liners (f_i)..

We give an example in Fig 6-2 from the freight list of *dayinghome.com*. For every route, the freight of different types of containers, different carriers and the periods of validity are listed, for more than 19 main routes and hundred ports (See table 6-2).

起运港	目的港	认证	船司	中转港	码头	20GP	40GP	40HQ	返利	舱位	截关	开船	行程	有效期
NINGBO	ROTTERD...	V1	NYK	BUSAN...	三期	525	950	1000	–	0	5	3	29	09.13 - 09.19
SHANGHA...	ROTTERD...	V2	HMM	直航	洋山	375	650	700	–	0	1	4	36	09.01 - 09.30
SHANGHA...	ROTTERD...	V1	EMC	直航	洋山	530	950	1050	–	0	5	7	34	09.06 - 09.30
SHANGHA...	ROTTERD...	V1	CSCL	直航	洋山	572	1044	1144	–	0	7	2	32	09.06 - 09.30
SHENZHE...	ROTTERD...	V1	HANJI	直航	盐田	520	930	980	–	0	6	1	32	09.15 - 09.30

Fig.6-2 Freight list from of dayinghome.com[59]

[59] http://www.dayinghome.com/ZHENGGUI/List?PODname=ROTTERDAM

Tab. 6-2 Layout of routes and ports[60]

Lines	Ports
Euro Base Port	FELIXSTOWE | ROTTERDAM | SOUTHAMPTON | HAMBURG | ANTWERP
Euro Remote Port	DUBLIN | GDYNIA | KOTKA | COPENHAGEN | ST.PETERBURG
Mediterranean Sea	VENICE | KOPER | IZMIR | ALEXANDRIA | ISTANBUL
Black Sea	CONSTANZA | ODESSA | ASHDOD | NOVOROSSIYSK | DAMIETTA
Red Sea	AQABA | JEDDAH | SOKHNA | PORT SUDAN | HODEIDAH
Middle East	DUBAI | KARACHI | BANDAR ABBAS | DOHA | DAMMAM
India and Pakistan	CHENNAI（MADRAS） | NHAVA SHEVA | CHITTAGONG | COLOMBO
South East Asia	YANGON | PORT KELANG | SINGAPORE | HOCHIMINH CITYCATLAI | BANGKOK
Japan and Korea	BUSAN | INCHON | OSAKA | KOBE | NAGOYA
Oceania	BRISBANE | SYDNEY | MELBOURNE | AUCKLAND | FREMANTLE
West of South America	BUENAVENTURA | MANZANILLO | GUAYAQUIL | CALLAO | SAN ANTONIO
East of South America	ASUNCION | ITAJAI | LAS PALMAS | SAN FRANCISCO | RIO GRANDE
Middle and South America	BUENOS AIRES | SANTOS | MEXICO CITY | MONTEVIEO | VALPARAISO
East Africa	DAR ES SALAAM | MOMBASA | PORT LOUIS | DJIBOUTI | TANGA
South Africa	DURBAN | CAPE TOWN | JOHANNESBURG | PORT ELIZABETH | MAPUTO
West Africa	APAPA | TEMA | TINCAN | LOME | COTONOU
North frica	ALGIERS | TRIPOLI | CASABLANCA | MISURATAH | BENGHAZI
Base Port of America and Canada	LOS ANGELES | NEW YORK | CHICAGO | MIAMI | NORFOLK
Inland Port of America	JACKSONVILLE | BALTIMORE

Hundreds of forwarder agents provide many freight rates of almost all ports globally. It is almost impossible for a single liner company to provide a detailed freight list to cover all these ports or even a large proportion of them. An even worse situation is that this freight list has to be changed every day since most of forwarder agents change the freight rates in a very fast manner. Therefore, we need to turn to e-booking platform to find the support on the sufficient and dynamic data sources. To this end, we start this pilot work by focusing mainly on China export freight rate, due to the availability of sufficient materials on the e-booking platforms based in China. We in the last section also show that a global container liner freight index can be achieved by extending our analysis to sufficient multi-nation e-booking platforms next.

Although this data source is focused mainly on China export freight rate now, a global container liner freight index can be provided based on multi-nation e-booking platforms next.

6.2 Algorithm of the daily container freight index

In this section, a framework is proposed to construct the daily container freight index (DCFI). The DCFI studied in this research is a kind of daily issued freight index for (global or regional) container liner markets based on data from a number of e-booking platforms. Compared with the SCFI issued by SSE, the DCFI is calculated with adjusted methodology and different data sources which can give more insightful information to shippers.

6.2.1 Basis

(1) Routes and base ports

Although freight data should cover lines and ports as more as possible, and exactly the

[60] http://www.dayinghome.com/

database really cover all of lines and ports in table 6-2, to be compared with the SCFI, the DCFI choose the same 15 lines from Shanghai and same 29 base ports of destination (table 6-3). Note that we admitted that the DCFI will be more representable if we include freight data to cover as many lines and base ports as possible, and this is straightforward extension from our method.

Tab. 6-3 Lines and base ports for the DCFI

No.	Line	Base port of destination
1	Shanghai-Europe	Hamburg, Rotterdam, Antwerp, Felixstowe, Le Haver
2	Shanghai-Mediterranean	Barcelona, Valencia, Genoa, Naples
3	Shanghai-Western of US	Los Angles, Auckland, Long Beach
4	Shanghai-Eastern of US	New York, Savanna, Norfolk, Charleston
5	Shanghai- the Persian Gulf	Dubai
6	Shanghai-Australia	Melbourne
7	Shanghai-Western Africa	Lagos
8	Shanghai-South Africa	Durban
9	Shanghai-South of America	Santos
10	Shanghai-Japan Kansai	Osaka, Kobe
11	Shanghai-Japan Kanto	Tokyo, Yokohama
12	Shanghai-South Eastern Asia	Singapore
13	Shanghai-South Korea	Busan
14	Shanghai-Taiwan	Kaohsiung
15	Shanghai-Hongkong	Hongkong

(2) Data sources of the DCFI

Now let us look into the data sources of the DCFI. In practice, most of shippers have no freight contracts directly with liner companies. They take the bill of lading and pay freight to forwarders or forwarder agents. This again confirms that the prices paid to forwarders, f_{ijk}, and forwarder agents, f_{ijkl}, the real transport cost faced by shippers. In our research, we focus on two main data sources, *365wuliu.com* and *dayinghome.com*, where most of their members are forwarders or forwarder agents. The headquarters of *365wuliu.com* and *dayinghome.com* are in Shanghai and Ningbo respectively. They collect the freight data through internet technology every day and make them publically accessible through their webpages. A better thing is that the data of the two data sources complement each other.

365wuliu.com and *dayinghome.com* together provided 1.2 million freight rate data during Oct. 17 to Dec. 05, 2014, totally for 7 weeks. We use this data, to design the weights of the DCFI, and make the verifications and tests.

6.2.2 Route freight index

Following the algorithm of the SCFI, the DCFI choose the same 15 lines in table 6-3. Therefore, there are 15 route freight indices to be calculated in identical method.

(1) Eliminating distorted data

Due to various source, it is quite possible to identify more than one or even many different freight rates for even a particular route from Shanghai to a port of destination, where the diversity

is caused by the bids from different forwarders and forwarder agents. Some of this data is taken on the rates as distorted, since they might be given with discounts. To this end, we set up a set of regulations to eliminate these distortions: 10% highest and lowest freight rates are excluded from our consideration.

(2) Average over different container types

From Fig. 6-2, it is easy to observe that the freight rates are usually differently set along with three different types: 20GP, 40GP and 40HQ. It is necessary to unify them into a unit of twenty-feet equivalent unit (TEU) by formula 6-1.

$$f^s = r_1 \times \frac{1}{2} \times f_{40GP} + r_2 \times f_{20GP} + r_3 \times \frac{\eta}{2} \times f_{40HQ} \quad (6\text{-}1)$$

In formula 1, f^s is the conversion freight rate, f_{40GP} is the freight rate for a 40 GP container, f_{20GP} is the freight rate for a 20 GP container, f_{40HQ} is the freight rate for a 40 HQ container. r_1 is the average rate of 40 GP container, r_2 is the average rate of 20 GP container and r_3 is the average rate of 40 HQ container in the route. $r_1 + r_2 + r_3 = 1$. According to the general situation, r_1=0.6, r_2=0.2, r_3=0.2. η is the conversion factor for changing the 40 HQ container to 40 GP container. One 40 GP container equals to two 20 GP containers.

(3) Calculation of route freight index

Route freight index can be calculated with formula 6-2.

$$I_i = \frac{1}{n_i} \sum_{j=1}^{n_i} f_{ij}^s \quad (6\text{-}2)$$

In formula 2, i is denoted the route number, j is denoted the number of base ports of destinations in i route, n_i is total number of base port of destination in i route, f_{ij}^s is conversion freight rate from Shanghai port to j port in i route.

6.2.3 The static DCFI

The SCFI is a composite index with static weights of 15 route freight indices. DCFI also will follow the same algorithm and make some change as different data sources.

(1) Arithmetic average

The calculation formula of the DCFI is similar with SCFI[61] as in formula 6-3.

$$DCFI = 1000 \times \sum_{i=1}^{m} \frac{w_i \times I_i}{I_{i0}} \quad (6\text{-}3)$$

In formula 6-3, m is total number of chosen routes, w_i is the weight of I_i, I_{i0} is the initial value of I_i.

(2) Negative freight rate

In container liner market, there is no negative freight because the data of freight rates are provided by liner companies. But in container forwarder markets, the negative freight rates exist.

[61] http://www.sse.net.cn/index/scfiintronew.jsp

Table 6-4 gives the examples for negative freight rates obtained from *365wuliu.com*.

Tab.6-4 Negative freight example[62]

Date / Route	Oct.17 2014	Oct.18 2014	Oct.19 2014	Oct.20 2014
Shanghai- Kaohsiung (USD/TEU)	-95	-95	-95	-95
Shanghai-Hongkong (USD/TEU)	-156.67	-163.33	83.33	-107.5

The reason of negative freight rates is not the topic of interest for this paper. In order to eliminate the negative effects, the absolute values of freight rates are included into our schemes. Therefore, formula 6-3 should be superseded by formula 6-4.

$$DCFI = 1000 \times \sum_{i=1}^{m} \frac{w_i \times \left[(I_i - I_{i0}) + |I_{i0}| \right]}{|I_{i0}|} \tag{6-4}$$

(3) Comparison with the SCFI

One problem is that initial dates of the SCFI and the DCFI are different. To let the DCFI and the SCFI are comparable, the initial dates for the two indices must be the same. (The initial date of the SCFI is Oct. 16, 2009. The first data of freight rates used for the DCFI is Oct.17, 2014.) To this end, we use formula 6-5 to recalculate the $SCFI_e$ from the SCFI.

$$SCFI_e = 1000 \times \frac{SCFI}{SCFI_0} \tag{6-5}$$

In formula 6-5, $SCFI_0$ is the value of the SCFI on Oct.17, 2014, the $SCFI_e$ and the SCFI are in same date.

(4) Result sample

Based on the data sources from *365wuliu.com* and *dayinghome.com*, the DCFI can be calculated by formula 6-4. Based on the data issued in the website of the SSE, the $SCFI_e$ can be calculated by formula 6-5.

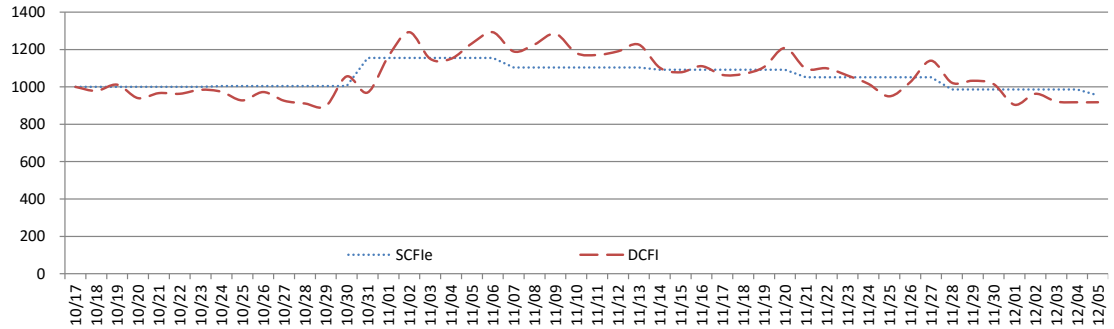


Fig. 6-3 Comparison of the DCFI and the $SCFI_e$

[62] Data source: www.365wuliu.com

The result is shown in Fig.6-3, where w_i of the DCFI is same as that of the SCFI. The digital result is listed in appendix.

6.2.4 The dynamic DCFI

For a composite index, weights of sub-index is also important issue. The SSE calculated w_i by an expert consultation in 2009. After that, w_i has not been changed although Shanghai container liner market have made great progress: container throughput of Shanghai port became top 1 in the world.

Some scholars suggested the dynamic weight is better than static weight. Shi Xin (1999) recommended dynamic weight for shipping index. ZHOU Pubin (2006) tested the dynamic weight with Shanghai port rate of container flow in EDI technology. Following their idea, algorithm of the dynamic DCFI is developed.

(1) Dynamic weighting scheme

As the SCFI and the DCFI above are based on the data of Shanghai Port, the dynamic weighting scheme of the SCFI and the DCFI can be taken from data sources of Shanghai International Port Group (SIPG). In table 6-5, the volume is the number of exports from Shanghai to the ports of destinations in Sep 2014. We suppose the weights of sub-indices are the shares of the export volumes of port containers. As the volumes are dynamic, the weights are also dynamic.

The dynamic weights can be calculated with formula 6-6.

$$W_{id} = \frac{V_{ri}}{V_a} \tag{6-6}$$

Tab.6-5 Weight of sub-indices

No.	Destination	Volume (TEU)	Dynamic Weight	Static Weight
1	Europe	180276.5	0.1604	0.0500
2	Mediterranean	70809.25	0.0630	0.0500
3	Western of US	241337	0.2147	0.0250
4	Eastern of US	83516.5	0.0743	0.0250
5	the Persian Gulf	78839.75	0.0701	0.0250
6	Australia	44045.25	0.0392	0.0500
7	Western Africa	13156.625	0.0117	0.0750
8	South Africa	13156.625	0.0117	0.0500
9	South of America	80938.5	0.0720	0.0250
10	Japan Kansai	64046.25	0.0570	0.0250
11	Japan Kanto	64046.25	0.0570	0.0250
12	South Eastern Asia	127675	0.1136	0.2000
13	South Korea	35205	0.0313	0.0750
14	Taiwan	24849.25	0.0221	0.1000
15	Hong Kong	2106	0.0019	0.2000
16	Total	1124003.75	1.0000	1.0000

In formula 6-6,

v_{ri}—export container volume of no.i route

v_a—total export container volume for all routes

w_{id}—the dynamic weight of no.i route.

(2)Calculate result of dynamic DCFI

Taking the dynamic weight in tale 6-5 in to formula 4, dynamic DCFI can be calculated. The $DCFI_d$ curve is the result in Fig.6-4.

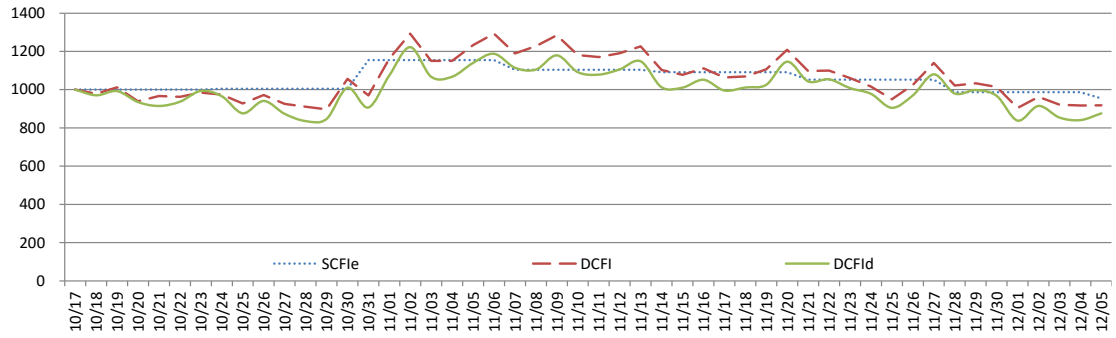


Fig.6-4 $SCFI_e$, DCFI and $DCFI_d$

6.3 Risk analysis

In this section, we implement the framework of the DCFI to some real investment problem. Similarly as the other markets, there also exist endogenous risks for the investments into the regional maritime transport markets. Here we use real data on the DCFI to illustrate how the DCFI can be used to measure these risks. To extend our analysis, we need to answer a question that how the DCFI can be practically used when the data is limited. The data used in this section are based on a fifty-day DCFI record. In this study, we intentionally use this small data set to illustrate how risk analysis can be achieved.

6.3.1 Simulation

We propose a bootstrap algorithm to estimate the distribution of the DCFI as follows. First, we denote the DCFI in day t by p_t for t=1,2,…,50 and use p_t to calculate the return rates for the index investment μ_t by the formula 6-7,

$$\mu_t = \frac{p_t - p_{t-1}}{d_t} \tag{6-7}$$

for t=1,2,…,50 and define p_0 =0. By doing so, we can define the concept of the investment return. The investment means that forwarders might invest into some maritime transport freights when the DCFI is at p_{t-1} in advance, one day ahead, to hedge the risk caused by the index p_t at day_t. Of course, the concept of return rates is borrowed from financial market and can be extended to any markets with price or index uncertainties. We denote the return rates derived from the DCFI in this fifty-day data set (See in tab B-32) as μ_t, t=1,2,…,50.

Bootstrap Algorithm

Step 1. For sample μ_t for $t = 1, 2, \cdots, 50$, compute its sample mean value $\bar{\mu}$ and sample variance $S_{\bar{r}}$.

Step 2. For kth simulation for $k = 1, 2, \cdots, K$:

a. Resample $\mu_1^*, \cdots, \mu_T^*$ for $T = 50$ with replacement from μ_t for $t = 1, 2, \cdots T$;
b. Compute sample mean $\bar{\mu}^*$ and sample variance $S_{\bar{r}^*}$ from new sample $\mu_1^*, \cdots, \mu_T^*$;
c. Let

$$P_k = \frac{\bar{r}^* - \bar{r}}{S_{\bar{r}}};$$

d. Reorder $P_{(1)} \leq P_{(2)} \leq \cdots P_{(K)}$.

Step 3. Return the bootstrap $1 - 2b$ two-sided confidence interval, which is

$$(\bar{\mu} - P_{(\lceil k(1-b) \rceil)} S_{\bar{r}^*}, \bar{\mu} - P_{(\lceil kb \rceil)} S_{\bar{r}^*}), \tag{6-8}$$

With $\lceil A \rceil$ is the smallest integer greater than or equal to A.

The following result presents the real distribution for DCFI and the simulation distribution P from $P_{(k)}$ for k=1,2,…, K for the DCFI.

6.3.2 Risk measure

Based on the simulated distribution, the loss of forwarders can be investigated further. Consider a representable forwarder who pay in one day advance (i.e. μ_t for t=1,2,…,50) for the container liner freight in the index, but this could make loss or profit for the forwarder since the index in day t+1 is going to be μ_{t+1}. It can be measured that the loss of a forwarder from the following disutility function (6-9):

$$l(z) = \exp(-\beta z) \tag{6-9}$$

for investment z on the DCFI.

Here we consider a case where a decision maker invests according to the DCFI, that is z= μ_t. One of the natural factors a decision maker needs to consider is the risk for such an investment. We investigate the risk for this investment by using a well-known utility-based shortfall risk (UBSR).

The UBSR is introduced by a loss function and a risk lever. Consider a investment position z over a fixed time horizon T which is defined on probability space (Ω , F, P). For instance, z could be the value of a portfolio of stocks or the value of an investment on the DCFI, etc. Let $l : \mathbb{R} \to \mathbb{R}$ be a convex loss function, that is, l is convex, increasing and not constant. We also define λ a point in the interior of the range of l. We write by l(-z) the value of loss function at financial position z. An acceptance set is hence defined as

$$\mathcal{A} := \{z \in \Omega : \mathbb{E}_P[l(-z)] \leq \lambda\}, \tag{6-10}$$

Where P is the distribution simulated from Bootstrap Algorithm. The set defined in (6-10) includes all investment position with their expected losses are no more than λ. For an investment position z, the UBSR is defined as the minimum capital investment added to z such that it is in the set $\mathcal{A}$., i.e.,

$$\mathrm{SR}_{l,\lambda}(z) := \inf\{m \in \mathbb{R} : m + z \in \mathcal{A}\}, \quad z \in \Omega. \tag{6-11}$$

In this chapter we may write $\mathrm{SR}_{l,\lambda}(z)$.

Proposition 1. *(Dunkel and Weber (2010) Let* $\mathrm{SR}_{l,\lambda}(z)$ *be Utility-Based Shortfall Risk associated with the convex loss function l and threshold lever* λ*. Suppose that random variable z* $\in \Omega$*. Then* $\mathrm{SR}_{l,\lambda}(z)$ *is solution* s^* *to*

$$\mathbb{E}_P[l(-z-s)] - \lambda = 0. \tag{6-12}$$

The above property indicates that $\mathrm{SR}_{l,\lambda}(z)$ for z can be solved by a root finding method.

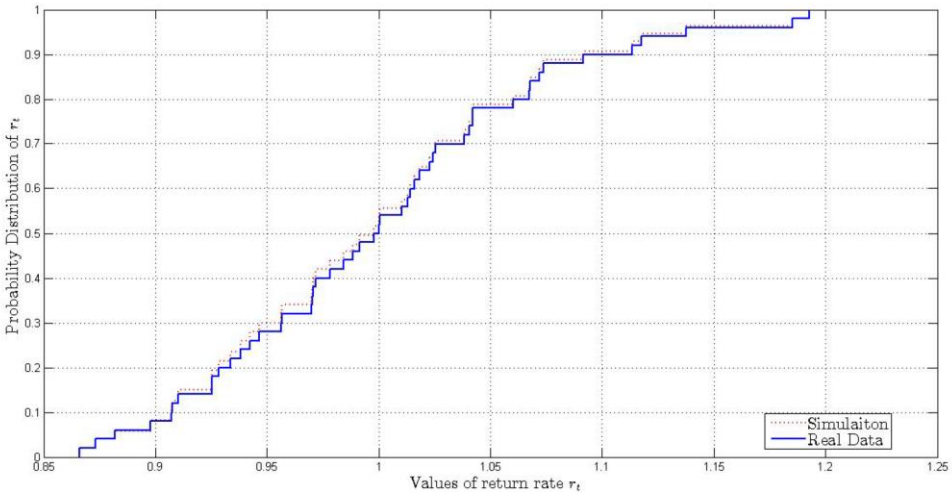


Fig. 6-5 Comparison of real and simulation distributions

According to sample average approximation framework, the real data set with sample size being 50 is hard to give an accurate estimation on the UBSR. Therefore, we use the bootstrap simulated distribution for the sampling. By doing so, we can implement the optimization problem and have the following distribution on the UBSR for the problem with λ =90%. (Fig.6-5)

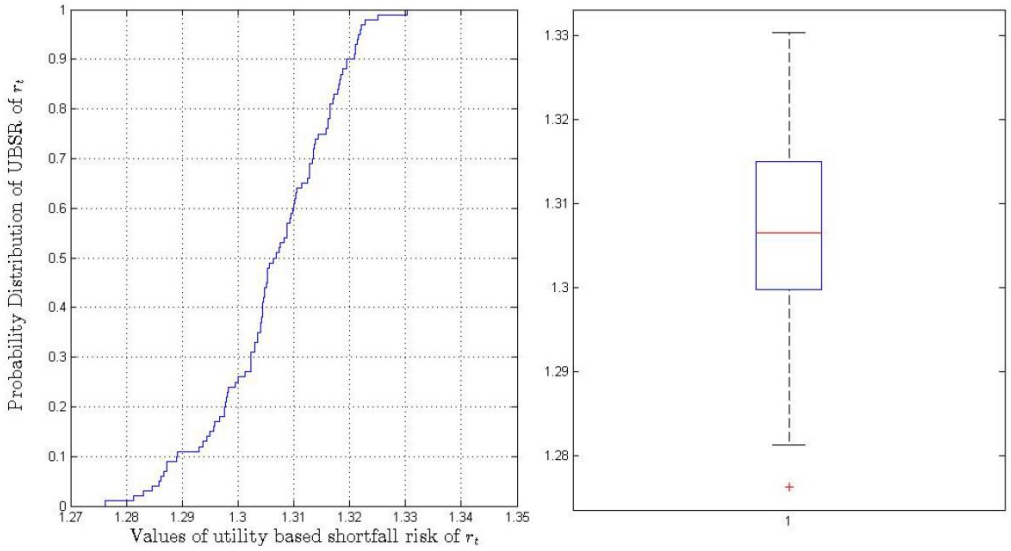


Fig. 6-6 The UBSR of loss function $l(\cdot)$ on the DCFI

From the results in Fig.6-6, we illustrate how the mechanism of DCFI can be used to give some basic but insightful information on the investment for the container liner market. The reason why the framework of the DCFI can be used in daily manner because it can capture the market dynamics in a fast manner than the CCFI and the SCFI; the second reason is that the freights included in the DCFI is purely on the freights faced by shippers instead of the freights from liners in the CCFI and the SCFI.

6.4 Summary

This chapter has explored the four-lever freights structure of container freight market. We illustrated that the freight faced by shippers are not directly from liners but forwarder agent, which are more relevant to shippers' cost. Again, by investigating the diversity at forwarder and forwarder agent side, we have pointed that despite of the monopolistic position of liners, shippers still can access to a perfectly competitive market where forwarders and forwarder agents might choose lower freights to attract more demands for their value-added service. Based on the above analysis, we have proposed an e-booking platform based container freight index, the DCFI. We also showed that, compared to the SCFI and the CCFI, this index can better characterize the fluctuation of freights as the outcomes of forwarders and forwarder agents' competition. Moreover, to illustrate how this index can be implemented into the real investment, we investigated a simulation method and carried out some numerical tests on the risk analysis.

Chapter 7 Conclusions and Suggestion

7.1 Conclusions

At the end of 19th Century, economists developed many indicators to illustrate the situation of National Economy or market, although they faced serious shortage of economic data. As the technology of data collection was very limited, economists developed a variety of different algorithms and the corresponding indicators until 1980s.

Since 1980s, with the development of computer and communication technology, especially in the 20th Century, human being has entered a brilliant intelligent time. In last 20 years, scientists setup a lot of databases to store huge scale data under the support of government. More and more governments and organizations are going to open their data sets to public. More and more data products are developed to support decision making for governments, organizations and companies. In real estate industry, iron and steel industry, auto industry……there are a lot of data products to be developed, including price index and prosperity index.

Prosperity indices are also called business cycle indicators or economic cycles monitoring indicators. Although these indicators have different names, their main functions are almost same. This kind of indices is widely used to characterize its macro-economic situation in many countries. Some institutes compare their competition powers among different countries with their prosperity indices. Some industry prosperity indices are developed to show the situation of special market. The real estate market and manufactory industry are examples.

The maritime transport market is a globalized market. This market can be divided into several parts according the nature character of cargoes and its business model. Tanker market, dry bulk market and liner market are three kinds of main types. All of them are in accordance with the operation of the market. The balance of supply and demand is the basic rule of this market. As the mechanism of markets is different, the types of market are different. Although there are many freight indices like as BDI, BCI, WS and CCFI, most of these indices mainly focus on specific market and just give the price cycles of different markets. For most investors, it is necessary to have the overview description of global maritime transport market. So the prosperity index of global maritime transport (PIGMT) is needed.

The methodology and algorithm of business cycle indices are useful for the PIGMT. This paper created the indicators framework and algorithm for the PIGMT by the method of composite index. 27 indicators chosen from over 100 indicators of 4 organizations constitute the basic framework of the PIGMT. The data of 16 years was collected to test the effectiveness of the method. The calculation result shows the PIGMT can describe the prosperity situation of the global maritime transport market correctly.

Chapter 6 illustrated that the freight faced by shippers are not directly from liners but forwarder agent, which are more relevant to shippers' cost. Based on the freight structure analysis, the DCFI, an e-booking platform based container freight index has been proposed. Compared to the SCFI and the CCFI, the DCFI can better characterize the fluctuation of freights as the outcomes of forwarders and forwarder agents' competition. Moreover, to illustrate how this index can be implemented into the real investment, we investigated a simulation method and carried out

some numerical tests on the risk analysis. If the global liner freight data can be obtained from more e-booking platform, the global container liner freight can be issued.

7.2 Some suggestion for further research

The research on the PIGMT and the DCFI has just started, there are several points which need to be improved at least:

⑴Indicators chosen cannot cover all of the market. As some indicators began in the middle of the calculation periods like the FFA, although the indicator framework includes the FFA and others, the calculation result was received without them. So the calculation periods should be adjusted to recent years. Then, the correction of the PIGMT could be surveyed further.

⑵The global maritime transport market consists of four parts: dry bulk market, tanker market, liner market and other vessel type market. This paper chose some indicators just for dry bulk market, tanker market and liner market without others as the relative indicators are seldom. Meanwhile, the method designed mixes all of 27 indicators together with different weight. Next, another way can be considered: calculating the prosperity index of branch market first, then combining the branch prosperity indices to be the index of all markest.

⑶This paper prove the possibility of the DCFI. With same method, the freight indices for ro-ro market, ferry market, cruise market, etc. can be developed. With more and more data products are being developed, the indices framework of the global maritime transport market will be fruitful.

⑷Every successful index is the result of sustaining research. The PIGMT and the DCFI are not exception. It needs to constantly be adjusted and modified in terms of indicators and the number of weight, more need is to perfect its algorithm with new calculation tools.

References

Alizadeh A.H., 2013, *Trading volume and volatility in the shipping forward freight market*[J], Transportation Research Part E: Logistics and Transportation Review, 49(1):250-265

Amromin G., Paulson A.L., 2009, *Comparing patterns of default among prime and subprime mortgages*[J], Economic Perspectives, pp.18-37

Andriosopoulos K., Doumpos M., Papapostolou N.C., Pouliasis P.K., 2013, *Portfolio optimization and index tracking for the shipping stock and freight markets using evolutionary algorithms*[J], Transportation Research Part E: Logistics and Transportation Review, 52:16-34

Angeloudis P., Greco Luciano, Bell M.G.H., 2015, *Strategic Maritime Container Transport Design in Oligopolistic Markets*[J], Transportation Research Procedia, 9:269-282

Artis M., Okubo T., 2008, *The Intranational Business Cycle: Evidence from Japan*[W], Centre for Growth and Business Cycle Research, Economic Studies.

Bate R., 2009, *What Is Prosperity and How Do We Measure It?*[W], Development Policy Outlook. 2009(3), www.aei.org

Born W. L., Pyhrr S.A., 1994, *Real Estate Valuation: The Effect of Market and Property Cycles*[J], Journal of Real Estate Research, 9(4):455-485.

Bry & Boschan, 1971, Cyclical Analysis of Time Series: Selected Procedures and Computer Programs[W], New York: NBER.

Burns A.F., Mitchell W. C., 1946, *Measuring Business Cycles*[W], New York:NBER.

Can A., Megbolugbe I., 1997, *Spatial Dependence and House Price Index Construction*[J], Journal of Real Estate Finance and Economics, 14:203-222.

Cao C., Hu S., 1989, *Balanced Growth Prosperity Index*[J], Forecasting. 1989(4):50-56.

Case K.E., 1992, The Real Estate Cycle and the Economy: Consequences of the Massachusetts Boom of 1984-87[J], Urban Studies. 29 (2):171-183

CCIEE, *History & Mission*[OL], http://english.cciee.org.cn/NewsInfo.aspx?NId=339

CEIN, *中经指数*[OL], http://serve.cei.gov.cn/index/index/zjzs.asp?default=1&three block code =130101&blockcode=dbzjzs&cedb=1

CEMAC. *关于我们*[OL], http://www.cemac.org.cn/gywm.html

CFLP. 2012, *China Manufacture PMI is 50.3% in Mar. 2012*[OL], http://www.chinawuliu. com.cn/ xsyj/201404/01/288413.shtml

Chen G., Zhao Y., 2012, *Study on Co-opetition of Port Supply Chain*[M], Shanghai: Shanghai Jiao Tong University Press, ISBN 978-7-313-08098-1

Chen J., Lu L., Lu J. J., Feng Y., Wu Y.. *The Framework Development of Shipping Market Early-Warning System by Using Prosperity Index: A Case Study of Shanghai Dry Bulk Shipping Market*[C]. Transportation Research Board Annual Meeting 2014 Paper #14-4860

Chen L., 2004, Enterprise Prosperity Situation and Macro Economy Operation[J], Management World. 2004(3):14-24.

Cheng M., Han Y., Yi Y., 2013, *Combination Forecasting Model and its Application for Business Cycles*[J], Statistics and Decision, 2013(19):10-12.

Clarksons, *About us: Our History*[OL], http://www.clarksons.com/about-us/our-history/

Corbett J.J., Winebrake J., 2008, *The Impacts of Globalisation on International Maritime*

Transport Activity[OL], http://www.oecd.org/greengrowth/greening-transport/41380820

Davies J.E., 1986, *Competition, Contestability and the Liner Shipping Industry*[J], Journal of Transport Economics and Policy, 20(3):299-312.

Davis J. H., 2004, *An Annual Index of U. S. Industrial Production, 1790–1915*[J], The Quarterly Journal of Economics, 119(4):1177-1215.

Davis M.A., Heathcote J., 2005, *Housing and the business cycle*[J], International Economic Review, 46(3):751–784.

Dong G., Zhao Y., 2013, *Liner route network evolution in Northeast Asia under the financial crisis*[J], Journal of Dalian Maritime University, 39(3):99-102

Dong W., Gao T., Jiang S., Chen L., 1998, *Analysis and Forecasting Methods of Economic Cycles*[M], Jilin: Jilin University Press. June 1998.

Drake P.R., 1998, *Using the Analytic Hierarchy Process in Engineering Education*[J], International Journal of Engineering Education, 14 (3):191–196.

Drewry, *About Drewry*[OL], http://www.drewry.co.uk/corporate/about.php

Dunkel J., Weber S., 2010, Stochastic root finding and efficient estimation of convex risk measure[J], Operations Research, 58(5):1505-1521

Duru O., Yoshida S., 2011, *Long Term Freight Market Index and Inferences*[J], The Asian Journal of Shipping and Logistics, 27(3):405-421

ECRI, *All Indexes*[OL], https://www.businesscycle.com/ecri-reports-indexes/all-indexes#

ESA, *About Us*[OL], http://www.esa.doc.gov/about-us

ESRI, *About ESRI*[OL], http://www.esri.go.jp/index-e.html

Fu D., Zhao Y., 2015, *Research on data source and algorithm of containerized freight index*[J], Journal of Dalian Maritime University, 41(3):87-92

Gan A., Qu L. 2010, *Shipping Finance*[M], Shanghai: Truth and Wisdom Press, Shanghai People Press, ISBN 978-7-5432-1847-5

Gertler M., Gilchrist S., 1994, *Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms*[J], The Quarterly Journal of Economics, 109(2):309-340.

Guo G., Zheng Z., 2010, An Empirical Test for the Effectiveness of China's Macroeconomic Leading Index and Coincident Index[J], The Journal of Quantitative & Technical Economics, 2010(10):131-144

Hayashia F., Prescott E.C., 2002, *The 1990s in Japan: A Lost Decade*[J], Review of Economic Dynamics. 5(1):206–235

Hayashida M., Ono H., Terao T., 2007, *Critical evaluation of the Hayashi- Prescott Hypothesis on Japan's Lost Decade*[OL], https://tobata.kitakyu-u.ac.jp/economy_new/research/files/ Hayashida_ Ono_Terao.pdf.

Hodrick R. J., Prescott E. C., 1997, *Postwar U.S. Business Cycles: An Empirical Investigation*[J], Journal of Money, Credit and Banking, 29(1):1-16.

Howe Robinson, *About Howe Robinson*[OL], http://www.shipbroking.com/about.php

Huang Y., Song J., Cheng X., Sun A., Xue Y., 1988, *Diffusion Index and its function in Business Cycle Analysis*[J], Forecasting. 1988(6):16-20

Iacoviello M., 2002, *House Prices and Business Cycles in Europe: a VAR Analysis*[W], Boston College.

Iacoviello M., 2005, House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle[J], The American Economic Review, 95(3):739-764

ICAP, *Markets/Shipping*[OL], http://www.icap.com/markets/shipping.aspx

Ikeda Y., Aoyama H., Yoshikawa H.,2013, *Synchronization and the Coupled Oscillator Model in International Business Cycles*[W] RIETI Discussion Paper Series 13-E-089. Oct. 2013

Informa, *Who We Are*[OL], http://www.informa.com/Who-We-Are/

Inkpen A., Moffet M.H. 2011, *The Global Oil & Gas Industry*[M], Oklahoma, US: PennWell Corporation, ISBN 978-1-59370-239-7.

Intertanko, 2013, *Annual Review and Report 2012/2013*[OL], www.intertanko.com.

ISM. February 2014 Manufacturing ISM® Report On Business®[OL], http://www.ism.ws/ismreport/mfgrob.cfm

ITO T., 1990, The Timing of Elections and Political Business Cycles in Japan[J], Journal of Asian Economics, 1(1):135-156.

JCRE, *About JCRE*[OL], http://www.jcer.or.jp/eng/about/

Kaiser R. W.,1997, *The Long Cycle in Real Estate*[J], Journal of Real Estate Research, 14(3):233-257

Kavussanos M.G., Alizadeh-M A.H., 2001, *Seasonality patterns in dry bulk shipping spot and time charter freight rates*[J], Transportation Research Part E: Logistics and Transportation Review, 37(6): 443-467

Kavussanos M.G., Nomikos N.K., 2000, Futures hedging when the structure of the underlying asset changes: The case of BIFFEX contracts[J], Journal of Futures Markets, 20(8): 775–801.

Kawasaki K., 2013, *How Does the Regional Monetary Unit Work as a Surveillance Tool in East Asia?* [W] RIETI Discussion Paper Series 13-E-026. April 2013

Kiyotaki N., West K.D., 1996, *Business Fixed Investment and the Recent Business Cycle in Japan*[W], NBER Macroeconomics Annual 1996, Vol. 11, pp. 277-344

Knauth O. W., 1923, Statistical Indexes of Business Conditions and Their Uses, Business Cycles and Unemployment[W], New York: NBER, pp.363–379.

Kobayashi K., Inaba M., 2006, *Business cycle accounting for the Japanese economy*[J], Japan and the World Economy. 18(4):418–440

Kong X., He G., 2007, *Develop and Application of the Prosperity index of China Auto Industry*[J],Statistic and Decision Making, 2007(3):66-67.

KPMG. *Ship financing in flux–Searching for a new course*[OL], https://www.kpmg.com/UK/en/IssuesAndInsights/ArticlesPublications/Documents/PDF/Market%20Sector/Transport/ship-financing-in-flux.pdf

Lahiri K., Stekler H., Yao W., etc. 2003, *Monthly Output Index for the U.S. Transportation Sector*[J], Journal of Transportation and Statistics, 6(2/3):1-27.

Leamer E.E., 2007, *Housing is the Business Cycle*[W], NBER Working Paper, No.13428.

Legatum Institute, 2009, *The 2009 Legatum Prosperity Index™*[OL], http://media.prosperity.com/2009/pdf/publications/PI2009_Brochure_Final_Web.pdf

Legatum Institute, 2010, *The 2010 Legatum Prosperity Index™*[OL], http://media.prosperity.com/2010/pdf/publications/PI2010_Brochure_Final_Web.pdf

Legatum Institute, 2011, *The 2011 Legatum Prosperity Index™*[OL], http://media.prosperity.

com/2011/pdf/publications/PI2011_Brochure_Final_Web.pdf

Legatum Institute, 2012, *The 2012 Legatum Prosperity Index™*[OL], http://media.prosperity.com/2012/pdf/publications/PI2012_Brochure_Final_Web.pdf

Legatum Institute, 2013, *The 2013 Legatum Prosperity Index™*[OL], http://media.prosperity.com/2013/pdf/publications/PI2013Brochure_WEB.pdf

Legatum Institute, 2014, *The 2104 Legatum Prosperity Index™*[OL], http://media.prosperity.com/2014/pdf/publications/PI2014Brochure_WEB.pdf

Legatum Institute, 2015, *The 2015 Legatum Prosperity Index™*[OL], http://media.prosperity.com/2015/pdf/publications/PI2015Brochure_WEB.pdf

Li G., 2010, *Prosperity Analysis of China Shipping Market*[OL], http://www.krs.co.kr/eng/SIMS/file/Session14%20Prosperity%20Analysis%20of%20China% 20Shipping%20Market.PDF

Liu P., Zhao Y., 2010, *The application of VaR model in FFA risk measurement*[J], Journal of Shanghai Maritime University. Vol.31, No.2, pp.80-83

Lloyd's List Intelligence, *About Lloyd's List Intelligence*[OL], http://www.lloydslist intelligence.com/llint/about -us.htm

Mitchell W.C., 1943, Twenty-third Annual Report of the National Bureau of Economic Research[W], New York: NBER, 1943. pp.5-13.

Moore G.H., 1983, *Business Cycles, Inflation, and Forecasting (Second edition)*[M], Cambridge, Mass: Ballinger Publishing Company.

National Statistic Bureau, *2013 年全国房地产开发和销售情况*[OL], http://www.stats.gov.cn/tjsj/zxfb/201401/t20140120_502096.html

NBER, *US Business Cycle Expansions and Contractions*[OL], http://www.nber.org/cycles/cyclesmain.html

NBER, *About the NBE*R[OL], http://www.nber.org/info.html

Ning X., Zhao Y., Chen F., 2013, Study On Prosperity Indices of Global Shipping Industry[J], Journal of Shanghai Jiao Tong University (Natural Science Edition), 47(3):417-422+427

NOEP. 2014, *State of the U.S. Ocean and Coastal Economies*[OL], http://www.OceanEconomics.org/nationalreport.

OECD, 2003, *Business Tendency Survey-A Handbook*[W], Paris: OECD Publication.

Onozaki T., Yanagita T., 2003, *Monopoly, oligopoly and the Invisible Hand*[J], Chaos, Solitons & Fractals. 18(3):537–547

Onozaki T., Yanagita T., Kaizoji T., Toyabe K., 2007,*Regional business cycle synchronization through expectations*[J], Physica A: Statistical Mechanics and its Applications. 383(1):102–107

O'Sullivan A., Sheffrin S.M., 2003, *Economics: Principles in Action*[M], New Jersey, USA: Pearson Prentice Hall.

Otsu K., 2011, *Accounting for Japanese Business Cycles: A Quest for Labor Wedges*[J], Monetary and Economic Studies. 2011(11)143-170

Pyhrr S.A., Poulac S.E., Born W.L., Born. 1999, Real Estate Cycles and Their Strategic Implications for Investors and Portfolio Managers in the Global Economy[J], Journal of Real Estate Research, 18(1):7-68.

Qing Q., Zhao Y., 2012, *The research and establishment of index of dry bulk shipping market in*

the world[J], Journal of Southwest University for Nationalities (Natural Science Edition), 2012(2):299-304

QMcMcQuilling Services, 2008, *Worldscale: A Primer*[W], The Baltic Exchange Tanker Derivatives Forum, New York, 13 March 2008

Qu L. Chi., Liu X. L., 2013, *Who Decided Shipping Indices?*[J], Pearl River Water Transport. 2013(2)

Reijer A. H. J., 2007, *Deviation Cycles in Manufacturing: Business Cycle Measurement and Leading Indicators*[J], Journal of Business Cycle Measurement and Analysis, 2007(1): 43-77

RIETI, *What is RIETI?* [OL], http://www.rieti.go.jp/en/

Rodrigue J. 2010, *Introduction: Drivers of Change in Transportation*[W], OECD: International Transport Forum 2010

Rodrigue J., 2013, *The 'Humble Hero' of the Global Economy: Containers*[OL], http://america. aljazeera.com/opinions/2013/12/the-humble-hero-oftheglobaleconomycontainers.html.

Rossello-Nadal J. 2001, Forecasting Turning Points in International Visitor Arrivals in the Balearic Islands[J], Tourism Economics, 7(4):365-380

Saeed N. 2013, Cooperation among freight forwarders: Mode choice and intermodal freight transport[J], Research in Transportation Economics, 42(1):77-86

Samuelson P.A., 1939, Interactions between the multiplier analysis and the principle of acceleration[J], Review of Economic Statistics. 21:75–78

Schönberger V. M.，Cukier K., 2012, *Big Data: A Revolution That Transforms How we Work, Live, and Think*[M], Houghton Mifflin Harcourt, ISBN 978-0544002692

Schumpeter J.A., 1954, *History of Economic Analysis*[M], London: George Allen & Unwin.

Sekimizu K., 2013, *Foreword of World Maritime Day. A Concept of a Sustainable Maritime Transportation System*[W], IMO, 2013.

Shanghai Shipping Exchange, *Brief Introduction*[OL], http://en.sse.net.cn/brief/intro- en.jsp

Shi X. 1999, *Research and thinking about Baltic Freight Index*[J], Statistical Research, 16(2):44-48

Shi Z., 1988, *The macroeconomy monitoring index system of Japan*[J], Foreign Economics & Management. 1988(9):40-42

Shi Z., Liu J., Wu T., 2007, The Empirical Research for Business Cycle in China Using the Multivariate Markov Regime-Switching Model[J], Application of Statistics and Management, 26(5):821-829

Shiller R.J., 2007, *Understanding Recent Trends in House Prices and Home Ownership*[W], NBER Working Paper No.13553.

Shimizutani S., Todo T., 2008, What determines overseas R&D activities? The case of Japanese multinational firms[J], Research Policy. 7(3):530–544

Simpson, Spence & Young, *About SSY*, http://www.ssyonline.com/about-us/

Slack B., Gouvernal, E. 2011, *Container freight rates and role of surcharge*[J], Journal of Transport Geography, 19(6):1482-1489

Smith A., 1904, *An Inquiry into the Nature and Causes of the Wealth of Nations*[M], London: Methuen and Co., Ltd.

Smith C.E., 2009,'Economic Indicators' in C. Wankel(ed.) Encyclopedia of business in Today's

World[W], California, USA.

Soufun Group, *About China Index Academy*[OL], http://industry.soufun.com/en/about_ us.html

Stein B., Morrison A., 2014, *The enterprise data lake: Better integration and deeper analytics* [OL], PwC Technology Forecast: Rethinking integration, Issue 1, http://www.pwc.com/us/en/technology-forecast/2014/cloud-computing/assets/pdf/pwc-technology-forecast-data-lakes.pdf

Stock J.H., Watson M. W., 2002, *Macroeconomic Forecasting Using Diffusion Indexes*[J], Journal of Business & Economic Statistics, 20(2):147-162

Stock J.H., Watson M.W. 1989, *New Indexes of Coincident and Leading Economic Indicators*[W], NBER Macroeconomics Annual 1989, Volume 4, MIT Press, pp.351-409

Stopford M., 2009, *Maritime Economics(3rd edition)* [M], London: Routledge.

Summers.L.H., 1986, *Some Skeptical Observations on Real Business Cycle Theory*[J], Federal Reserve Bank of Minneapolis Quarterly Review 10, 23–27.

SUN Guangsheng. Economic and Industrial Fluctuations (1986-2003): A Preliminary Study of Correlation, Features and Driving Forces[J], Social Sciences in China, 2006(3):62-74.

Tan A., Zhao Y., Zhang D., Hilmola O., 2014, *State of third party logistics providers in China*[J], Industrial Management & Data Systems, 114(9):1322-1343

TCB, *About U*s[OL], https://www.conference-board.org/about/index.cfm?id=1980

The Baltic Exchange, 2012, *The Baltic Code 2012*[OL], http://www.balticexchange.com/media/pdf/Baltic_CODE.pdf

The Economist. *Our interactive guide to America's housing market*[OL], http://www.economist.com/ blogs/graphicdetail/2014/02/us-house-prices

The Robert S. Strauss Center, 2013, *The Tanker Market*[OL], https://strausscenter.org/hormuz/the-tanker- market.html

Tian Q., Tang H., 2011, *Research on Cycle Division and Fluctuation Trend for China Economy*[J], Statistics and Decision, 2011(14):109-111.

UNCTAD. 2015, *Maritime Transport Review 2015*[M], ISBN 978-92-1-112892-5. Geneva.

Vassiliou M., 2009, *Historical Dictionary of the Petroleum Industry*[M], Lanham, MD: Scarecrow Press, ISBN 0-8108-5993-9.

Waldrop M. 2008. *Big data: Wikiomics*. Nature 455, 22-25 (2008) | doi:10.1038/455022a. Published online 3 September 2008

Wang J., 2006, *Analysis of the Features of the Business Cycles in the Transient China and Studies on the Application of the Monitoring Methods*[D], Jilin University.

Wang J., Cheng J., Yang X., 2007, *Building SW-Type Leading Indices: An Empirical Study*[J], Chinese Journal of Management Science, 15(4):116-123.

Wang J., Xue P., 2012, Research on the Compilation of China Transportation Service Index and its Application[J], Statistics & Information Forum, 27(4):72-76.

Wang S., Luo L., 1996, *Initial Study of Business Cycle Analysis in Our Macro-economic*[J], Systems Engineering Theory & Practice. 1996(8):79-83

Wang X., Sun X., 2015, *Shipping Derivatives and Risk Management*[M], Shanghai: Shanghai Jiao Tong University Press. ISBN: 978-7-31312-439-5

Wei Z., Shen J., Zhang Z., Shi D., 2006, *Research on Prosperity Index of Logistics*

Transportation[J], Journal of Highway and Transportation Research and Development, 23(5):138-142.

Wheaton W. C., 1999, *Real Estate "Cycles": Some Fundamentals*[J], Real Estate Economics, 27(2): 209–230

Wikipedia, *Bloomberg_L.P.* [OL], http://en.wikipedia.org/wiki/Bloomberg_L.P.

Wikipedia, *Lloyd's List*[OL], http://en.wikipedia.org/wiki/Lloyds_List

Worldscale, Introduction to Worldscale Freight Rate Schedules[OL], http://www.worldscale.co.uk/

Wright R., 2008, *Collapse in dry bulk shipping rates unprecedented in its severity*[OL], http://gulfnews.com/business/shipping/collapse-in-dry-bulk-shipping-rates-unprecedented-in-its-severity-1.147218.

WTO. 2013, *World Trade Report 2013*[OL], http://www.wto.org/english/res_e/publications_e/wtr13_ e.htm

WTO. 2015, *World Trade Report 2015*[OL], https://www.wto.org/english/res_e/booksp_e/world_trade_ report15_e.pdf

Wu D., 1959, The character of postwar economic crisis and business cycle of United States[J], Teaching and Research. 1959(6).

Wu J., Dong W., 1986, *Economics Models and its Application*[M], Beijing: Economics Science Press. Oct. 1986.

Xiang J., Lin Y., Wang J., 2000, *Monitoring and Pre-Warning for Economy Cycle*[M], Beijing: China Standard Press.

Yanagita T., 2000, *International Monetary Fund Conditionality and the Korean Economy in the Late 1990s*[M], in Peter C.Y. Chow and Bates Gill, editors, Weathering The Storm, Washington, D.C.: Brookings Institution Press

Yang D., Liu M., Shi X., 2011, *Verifying liner Shipping Alliance's stability by applying core theory*[J], Research in Transportation Economics. 32(1):15-24

Yu Y., Zhao Y., *Correlation between Tanker Freight and the Price of Spot Crude Oil-Based on Granger Causality Analysis*[J], Journal of Chongqing Jiao Tong University (Natural Science Edition), 31(5):1095-1100

Yuan X., 2014, *The Shipping Finance Derivative Market*[M], Shanghai: Shanghai Pujiang Education Press. ISBN 978-7-81121-335-5

Zhang L., Pang S., Liu B., 2009, Review and Prospect for the Research on Prosperity Index of Tourism[J], Tourism Science, 23(5):21-28.

Zhang Y., Han Y. 2016, *Shipping Big Data*[M], Shanghai: Shanghai Science and Technology Press. ISBN 978-7-5478-2683-6

Zhang Y., Wang B., Tan Z., 2011, *Research on the Method of Shipping Risk Early-Warning Based on Matter-Element Theory*[J], Journal of Shanghai Jiao Tong University (Natural Science Edition.), 16(2):252-256.

Zhang Y., Wang Y., 2010, *Research on relevance between CCFI and actual prices*[J], Navigation of China, 33(2):95-99

Zhao Y., 2012, *A review of 2011 global shipping market and Shanghai shipping index (SSI) trend analysis*[M], in World Economic Analysis and Outlook(2011-2012), Beijing: Social Sciences

Academic Press, pp.266-273

Zheng J, 2013, Study of China's Economic Cycles Monitoring Indicators System, Beijing: China Statistics Press.

Zheng X., 2010, *China Economic Analysis & Outlook*[M], Beijing: Social Science Academic Press (China). Jan. 2010. pp.490-497

Zheng X., 2010, *World Economic Analysis & Outlook*[M], Beijing: Social Science Academic Press (China). Jan. 2010. pp.627-659

Zhou D., Zhen H., 2010, Development Trends of China Shipping Industry Based On China Shipping Prosperity Index[J], Shipping Management, 23(3):11-13

Zhou P., 2006, The compilation and technical analysis of container freight index based on the Electronic Data Interchange[J], Navigation of China. 29(3):82-86

Zhu J., 1965, Critique on Industrial Production Index of American Federal Reserve[J], Journal of Wu Han University. 1965(1):48-68.

Zou Z., Lin C., Lin X., Yang M., 2012, *Forecast Turning Point of Economy Cycles with Composite Index*[J], Economic Research Guide, 2012(3):8-10.

Notes:

[J]: the paper published in a journal

[W]: the paper published as a working paper

[OL]: the article published on webpage

[M]: the book published

[D]: the Phd dissertation

[C]: the conference paper

Appendix

A. Processed data of indicators chosen

A-1 Monthly order volume of bulk carrier (10^6DWT)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	33.71	35.74	23.96	31.83	55.94	69.08	76.25	106.65	247.24	320.94	300.54	305.63	232.56	139.74	171.27	176.08
Feb	34.36	33.84	21.75	34.73	56.70	78.28	80.33	111.95	260.64	322.42	307.02	302.83	223.08	136.12	180.74	168.59
Mar	34.85	33.01	21.68	35.96	56.95	78.54	80.21	117.95	268.38	322.19	307.22	301.09	217.00	134.55	183.41	162.92
Apr	35.70	30.76	20.87	37.84	59.56	78.14	82.58	126.83	277.19	319.50	307.61	293.03	205.52	131.84	183.41	157.02
May	36.35	31.09	23.62	39.58	62.88	77.34	82.83	136.75	290.90	315.82	310.15	288.28	196.78	131.95	184.19	154.28
Jun	36.75	29.89	22.86	40.95	63.17	76.92	84.14	154.32	297.18	313.10	317.04	281.59	184.74	137.81	185.06	149.70
Jul	36.77	28.43	24.95	44.91	64.26	76.91	83.29	165.52	300.87	310.14	321.21	277.76	173.56	140.46	187.08	146.15
Aug	36.56	27.88	24.96	48.10	65.78	77.22	87.90	176.02	317.86	311.47	312.69	270.36	167.11	142.98	186.35	142.70
Sep	36.44	27.29	25.69	47.50	65.87	77.30	87.86	190.50	320.71	309.79	309.23	267.22	163.22	144.97	186.45	139.53
Oct	35.07	24.93	27.91	48.39	66.73	75.90	92.01	202.92	326.48	305.26	307.21	255.11	155.05	145.77	184.32	138.41
Nov	35.41	24.91	29.47	51.64	67.92	75.52	94.68	218.26	326.54	303.73	302.90	248.49	148.54	151.27	180.76	134.07
Dec	35.31	24.08	29.63	52.02	67.94	74.24	97.69	228.03	322.99	301.96	300.95	239.96	142.21	157.60	176.99	130.43

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-2 Monthly order volume of tanker (10^6DWT)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	1.86	1.72	1.90	4.35	5.65	4.79	6.76	5.68	5.40	1.60	1.04	1.18	1.69	2.67	3.77	3.99
Feb	2.08	2.68	0.33	4.87	4.53	1.38	6.34	3.93	1.85	0.19	2.66	0.43	0.64	3.84	3.29	5.65
Mar	2.30	3.27	1.47	4.61	2.76	0.87	18.40	5.08	3.63	0.56	1.29	0.44	1.00	1.48	3.62	2.22
Apr	4.49	2.86	2.05	3.30	3.43	1.95	6.70	3.61	8.21	0.04	3.89	1.43	0.61	3.33	1.61	1.89
May	1.66	1.64	2.34	4.20	1.41	4.99	2.96	3.68	9.02	0.00	1.41	1.14	2.16	1.32	1.77	4.56
Jun	6.20	3.39	1.33	5.34	3.47	3.25	6.09	5.06	6.01	0.22	4.90	0.49	0.58	1.61	2.26	7.35
Jul	2.25	1.31	1.73	5.43	4.45	3.46	7.42	3.86	4.95	1.29	4.98	1.23	0.73	0.34	2.27	3.87
Aug	3.29	2.65	0.86	1.90	1.13	0.37	8.24	2.55	10.17	3.81	4.32	0.46	0.82	3.89	1.23	3.31
Sep	2.74	2.71	1.52	3.04	2.14	1.14	6.20	3.10	3.76	0.96	4.94	0.46	0.44	2.03	2.62	4.74
Oct	3.54	1.23	2.01	3.13	3.22	2.01	4.37	3.88	0.47	2.38	3.40	0.36	1.31	2.41	1.95	2.80
Nov	1.93	0.62	1.63	3.04	3.07	2.23	9.71	3.60	0.78	0.81	2.67	0.35	2.33	3.10	0.69	3.12
Dec	3.32	0.32	3.09	5.63	2.52	3.58	7.42	3.01	0.72	3.32	2.85	2.10	3.64	11.34	3.63	4.67

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-3 Monthly order volume of container vessel (10^6TEU)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	0.93	1.43	1.34	1.12	2.63	3.63	4.35	4.67	6.58	6.19	4.94	3.85	4.36	3.43	4.04	3.50
Feb	1.06	1.46	1.29	1.18	2.75	3.85	4.38	4.62	6.63	6.02	4.82	3.83	4.26	3.52	4.13	3.49
Mar	1.11	1.50	1.26	1.31	2.84	4.05	4.37	4.59	6.64	5.94	4.71	4.04	4.13	3.48	4.09	3.40
Apr	1.19	1.53	1.18	1.35	3.07	4.27	4.30	4.65	6.53	5.83	4.58	4.11	3.93	3.36	3.98	3.44
May	1.27	1.55	1.15	1.42	3.22	4.35	4.28	4.79	6.55	5.70	4.34	4.07	3.80	3.36	3.90	3.51
Jun	1.28	1.60	1.10	1.56	3.26	4.50	4.29	4.98	6.47	5.61	4.21	4.10	3.65	3.49	3.86	3.60
Jul	1.36	1.55	1.09	1.54	3.25	4.62	4.64	5.30	6.80	5.50	4.07	4.53	3.56	3.46	3.71	3.50
Aug	1.41	1.51	1.13	1.87	3.31	4.58	4.69	5.70	6.62	5.42	3.92	4.46	3.64	3.65	3.53	3.79
Sep	1.41	1.48	1.10	1.94	3.42	4.56	4.77	6.08	6.57	5.36	3.82	4.50	3.58	3.97	3.64	3.74
Oct	1.42	1.42	1.06	2.17	3.47	4.54	4.82	6.27	6.48	5.26	3.88	4.45	3.55	3.89	3.73	3.95
Nov	1.43	1.39	1.06	2.36	3.51	4.47	4.82	6.48	6.36	5.18	3.81	4.47	3.52	3.96	3.65	3.81
Dec	1.48	1.36	1.07	2.54	3.56	4.39	4.72	6.53	6.28	5.05	3.85	4.43	3.46	3.96	3.54	3.87

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-4 Capacity of bulk carrier (10^6DWT)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	267.16	274.87	286.93	294.63	301.84	322.39	345.28	368.39	392.91	419.34	461.86	540.46	620.96	686.68	726.05	757.85
Feb	268.80	276.89	289.04	295.76	303.92	324.34	348.26	370.87	394.85	420.26	468.86	551.36	631.24	694.45	731.98	763.25
Mar	269.21	278.35	289.78	295.89	305.41	325.53	349.58	372.71	396.43	422.55	473.54	554.09	636.30	695.22	734.26	762.84
Apr	270.19	280.77	291.05	296.81	306.82	328.26	351.89	375.00	398.79	425.22	480.69	559.59	642.49	700.23	738.87	763.28
May	271.14	281.22	291.43	297.39	307.87	330.29	354.17	377.45	400.21	427.67	486.85	564.20	648.04	703.61	740.98	761.70
Jun	271.35	282.07	292.56	297.86	309.76	332.19	355.18	379.10	403.09	430.43	493.05	571.01	654.86	706.73	742.13	762.09
Jul	272.06	283.46	292.93	298.78	311.36	333.62	357.48	380.93	406.04	434.43	499.64	576.67	665.79	709.24	745.47	764.23
Aug	272.38	285.30	293.47	298.87	313.31	335.98	358.81	383.68	408.82	439.46	507.43	583.96	670.68	712.71	748.77	767.96
Sep	273.24	285.85	293.67	299.78	314.39	337.61	360.82	385.05	412.16	443.57	512.54	589.02	673.85	714.48	748.91	770.17
Oct	274.24	287.70	293.93	300.29	316.73	340.26	362.85	386.78	415.50	448.80	520.36	599.60	678.42	716.89	753.13	773.55
Nov	274.65	287.70	294.18	301.09	318.02	342.16	364.94	388.08	417.63	453.59	526.77	606.23	681.53	721.29	756.27	775.99
Dec	275.20	287.24	294.38	301.52	320.86	344.28	366.63	390.70	419.21	458.36	534.01	614.35	685.09	725.11	756.91	777.18

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-5 Capacity of tanker (10^6DWT)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	285.62	292.39	287.53	292.02	301.09	317.96	340.80	360.13	381.66	400.44	431.15	448.07	473.94	492.27	500.93	507.87
Feb	286.61	292.87	286.45	293.38	303.02	319.74	340.56	362.05	380.25	406.23	433.08	452.23	477.55	495.29	502.14	509.76
Mar	285.15	293.18	284.59	295.34	303.44	321.23	342.76	362.92	381.91	408.84	433.37	453.48	477.89	497.09	502.18	510.50
Apr	285.52	293.74	286.18	297.52	304.69	322.84	344.77	366.13	383.35	412.71	436.01	456.40	478.74	498.87	502.37	511.27
May	286.32	294.77	285.69	300.32	305.68	324.05	346.25	368.44	386.10	416.66	436.67	459.26	480.65	500.64	502.07	513.47
Jun	286.93	294.36	284.34	296.83	306.49	325.96	347.56	369.89	387.60	419.17	438.10	460.11	482.75	501.95	502.73	514.91
Jul	288.14	293.31	286.61	297.07	308.45	328.00	349.64	372.19	388.55	423.04	440.39	463.54	485.65	503.25	503.76	516.50
Aug	288.04	293.88	287.00	298.37	309.67	330.43	352.35	375.29	387.38	426.48	442.89	466.40	487.40	503.01	504.31	518.06
Sep	289.45	293.92	287.85	297.22	312.10	332.28	353.88	375.47	388.46	427.06	443.60	467.45	487.73	503.15	505.18	518.83
Oct	291.35	294.05	288.02	298.60	313.88	334.21	356.06	377.47	390.55	428.83	444.44	469.87	490.21	503.07	505.72	521.35
Nov	291.59	292.50	288.88	298.55	315.52	336.33	357.93	379.15	394.61	430.94	446.23	471.54	492.31	501.69	506.07	522.42
Dec	292.43	288.89	290.38	300.38	317.95	338.84	358.75	380.04	398.03	430.14	447.82	474.43	492.45	501.01	508.13	523.82

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-6 Capacity of Container Vessels (10^9TEU)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	4.47	4.92	5.50	6.08	6.62	7.27	8.21	9.57	10.86	12.25	12.98	14.22	15.34	16.25	17.14	18.26
Feb	4.50	4.95	5.56	6.12	6.65	7.32	8.30	9.67	10.99	12.35	13.07	14.33	15.42	16.32	17.21	18.40
Mar	4.51	4.99	5.59	6.16	6.69	7.35	8.38	9.75	11.11	12.45	13.12	14.37	15.49	16.35	17.19	18.47
Apr	4.54	5.03	5.67	6.20	6.76	7.44	8.52	9.89	11.27	12.52	13.25	14.47	15.67	16.49	17.35	18.63
May	4.56	5.07	5.71	6.26	6.81	7.52	8.59	10.00	11.39	12.60	13.39	14.67	15.76	16.60	17.52	18.73
Jun	4.60	5.11	5.76	6.30	6.84	7.61	8.74	10.12	11.51	12.65	13.49	14.84	15.90	16.70	17.57	18.87
Jul	4.66	5.18	5.81	6.38	6.92	7.67	8.85	10.20	11.64	12.71	13.62	14.93	16.02	16.81	17.70	19.05
Aug	4.67	5.22	5.86	6.42	6.99	7.76	8.96	10.36	11.82	12.72	13.87	15.02	16.06	16.91	17.87	19.20
Sep	4.71	5.27	5.88	6.46	7.03	7.85	9.08	10.47	11.92	12.76	13.97	15.10	16.10	16.95	17.92	19.35
Oct	4.77	5.34	5.95	6.50	7.09	7.94	9.19	10.57	12.02	12.84	14.08	15.15	16.17	17.08	17.98	19.48
Nov	4.81	5.39	5.99	6.52	7.14	8.02	9.30	10.67	12.14	12.88	14.16	15.21	16.19	17.12	18.06	19.61
Dec	4.85	5.43	6.04	6.59	7.21	8.13	9.44	10.79	12.20	12.93	14.17	15.27	16.24	17.15	18.16	19.69

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-7 Monthly trade value of grain (10^9USD, FAS)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	5.96	6.09	7.35	7.06	8.30	10.18	10.64	12.47	19.96	13.95	16.50	20.45	25.54	21.70	23.75	20.75
Feb	5.74	6.19	6.94	6.49	7.93	8.99	8.92	12.29	18.57	14.11	14.33	19.51	25.74	20.16	23.35	20.99
Mar	6.69	6.73	7.86	7.35	9.14	10.33	10.82	12.40	18.60	18.50	17.25	20.45	22.81	22.42	23.40	24.81
Apr	6.09	6.48	7.61	7.34	8.46	9.54	10.22	13.21	18.40	17.78	17.31	25.45	22.08	21.72	23.13	26.46
May	6.46	6.52	7.10	7.90	8.83	9.47	11.85	13.16	18.54	15.95	18.73	25.58	20.43	24.64	23.32	23.74
Jun	5.79	5.60	6.37	7.23	8.03	8.59	9.51	12.38	15.52	15.62	17.39	25.78	21.50	22.88	19.52	23.24
Jul	5.61	5.65	6.05	7.37	8.89	8.57	9.82	12.46	19.02	14.84	17.53	21.53	19.85	23.06	23.92	22.08
Aug	6.23	6.32	6.46	7.91	9.19	8.82	11.29	15.77	19.31	14.81	16.51	19.88	20.77	21.71	24.29	22.03
Sep	6.54	5.73	5.81	8.08	9.35	8.69	10.48	15.89	19.03	15.50	18.24	20.80	21.45	21.36	23.93	23.07
Oct	5.76	5.75	6.02	7.96	8.32	10.15	10.67	15.02	18.25	12.96	15.92	20.18	18.75	20.94	22.95	19.29
Nov	5.65	5.98	6.04	7.48	9.01	8.71	9.99	14.48	15.50	12.79	15.28	18.78	20.67	20.10	19.49	21.76
Dec	5.77	5.79	6.22	8.56	9.27	9.65	10.44	13.65	14.54	16.34	15.52	20.70	20.48	23.05	19.64	24.31

Data Source: UNCTAD database

A-8 Monthly trade value of iron ore (10^9USD, FAS)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	0.80	0.70	0.79	0.96	1.27	2.25	2.81	3.75	5.72	3.46	9.06	10.84	12.15	11.90	11.61	7.36
Feb	0.75	0.74	0.67	0.90	1.45	2.05	2.52	2.98	5.58	4.38	7.75	9.77	12.85	11.60	9.65	6.92
Mar	0.76	0.77	0.82	0.92	1.50	2.64	2.90	3.66	5.43	4.60	8.76	12.09	11.38	11.28	10.98	6.92
Apr	0.78	0.78	0.90	0.93	1.50	2.45	2.71	3.53	6.12	5.09	7.95	11.58	11.46	12.72	10.19	6.81
May	0.86	0.79	0.83	1.01	1.19	2.32	2.61	3.18	5.75	4.86	8.20	12.50	11.16	11.95	10.21	6.50
Jun	0.75	0.67	0.73	0.94	1.30	2.27	2.88	3.01	5.74	4.97	8.69	12.18	10.62	11.93	10.10	6.19
Jul	0.81	0.82	0.88	0.96	1.49	2.24	2.60	3.51	5.93	5.35	8.53	12.85	10.20	12.33	9.68	6.41
Aug	0.86	0.77	0.87	0.90	1.32	2.50	3.17	3.31	5.58	4.83	9.17	14.56	10.06	11.60	9.14	6.46
Sep	0.73	0.75	0.89	1.02	1.54	2.37	2.53	3.46	5.83	6.01	9.14	13.87	9.98	12.11	8.86	5.76
Oct	0.74	0.77	0.89	0.92	1.35	2.34	2.68	3.42	5.17	4.68	9.85	13.66	9.56	10.74	9.76	5.50
Nov	0.78	0.77	0.87	0.94	1.48	2.73	2.87	3.69	5.03	4.10	8.66	13.78	9.08	10.45	8.99	5.56
Dec	0.77	0.79	0.84	1.08	1.69	2.58	3.39	3.60	5.26	4.50	10.42	15.55	8.07	10.94	8.91	5.65

Data Source: UNCTAD database

A-9 Monthly trade value of coal (10^9USD, FAS)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	0.18	0.21	0.21	0.31	0.65	0.52	0.52	0.59	1.06	0.30	0.67	0.70	0.72	0.53	0.48	0.39
Feb	0.17	0.17	0.17	0.29	0.62	0.48	0.43	0.56	0.94	0.28	0.59	0.66	0.73	0.47	0.43	0.35
Mar	0.19	0.18	0.18	0.30	0.70	0.49	0.48	0.61	1.14	0.30	0.62	0.78	0.72	0.50	0.52	0.38
Apr	0.17	0.20	0.20	0.30	0.73	0.55	0.47	0.64	1.17	0.29	0.70	0.79	0.72	0.56	0.54	0.38
May	0.18	0.20	0.20	0.30	0.74	0.54	0.51	0.61	1.17	0.28	0.72	0.74	0.63	0.58	0.54	0.36
Jun	0.18	0.19	0.19	0.29	0.71	0.52	0.47	0.59	1.15	0.37	0.72	0.84	0.68	0.57	0.53	0.41
Jul	0.19	0.20	0.20	0.29	0.68	0.51	0.48	0.62	1.09	0.35	0.71	0.79	0.64	0.56	0.50	0.41
Aug	0.20	0.20	0.20	0.30	0.74	0.50	0.47	0.62	1.18	0.32	0.72	0.89	0.59	0.58	0.54	0.44
Sep	0.19	0.19	0.19	0.30	0.67	0.52	0.49	0.63	1.25	0.37	0.74	0.85	0.56	0.59	0.57	0.41
Oct	0.19	0.19	0.19	0.32	0.73	0.55	0.48	0.61	1.26	0.37	0.76	0.86	0.54	0.60	0.58	0.42
Nov	0.18	0.17	0.17	0.31	0.67	0.46	0.49	0.64	1.21	0.33	0.71	0.85	0.55	0.56	0.56	0.42
Dec	0.18	0.19	0.19	0.32	0.74	0.53	0.52	0.70	1.14	0.38	0.76	0.96	0.58	0.60	0.52	0.38

Data Source: UNCTAD database

A-10 Monthly trade value of crude oil (10^9USD, FAS)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	35.43	32.44	32.41	39.72	53.13	75.88	89.66	113.28	153.24	118.86	148.39	180.76	236.75	207.16	209.40	130.49
Feb	36.22	33.16	33.13	40.60	54.32	77.57	89.40	111.35	152.65	115.90	148.12	175.98	214.23	209.40	222.87	123.10
Mar	37.00	33.88	33.85	41.48	55.50	79.25	106.88	128.36	166.39	131.84	175.43	216.60	262.75	222.87	217.39	114.72
Apr	38.58	35.32	35.29	43.25	57.86	82.63	97.02	121.56	174.35	126.56	167.59	203.30	230.40	217.39	247.57	111.25
May	38.97	35.68	35.65	43.69	58.45	83.47	105.68	126.94	170.66	127.45	167.03	210.58	228.54	247.57	221.75	117.38
Jun	39.76	36.40	36.37	44.57	59.63	85.16	107.51	129.75	175.22	138.97	175.64	211.53	228.16	221.75	240.21	117.58
Jul	40.15	36.76	36.73	45.01	60.22	86.00	102.10	129.98	183.81	144.50	175.91	210.41	254.16	240.21	215.51	113.77
Aug	40.94	37.48	37.45	45.90	61.40	87.69	102.91	126.46	161.89	132.53	168.36	207.93	228.41	215.51	234.60	113.50
Sep	41.73	38.20	38.17	46.78	62.58	89.37	109.46	132.19	169.76	152.03	182.47	212.39	203.03	234.60	233.47	107.30
Oct	42.51	38.92	38.89	47.66	63.76	91.06	110.46	145.20	161.36	161.60	190.15	208.87	209.00	233.47	219.01	108.87
Nov	43.30	39.64	39.61	48.54	64.94	92.74	113.39	146.50	133.94	163.31	191.89	210.43	236.50	219.01	242.33	105.65
Dec	37.79	34.60	34.57	42.37	56.68	80.94	108.56	134.24	125.23	146.97	189.84	204.22	239.98	242.33	197.62	101.70

Data Source: UNCTAD database

A-11 Monthly trade value of finish products (10^9USD, FAS)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	185.96	177.29	186.65	211.66	254.67	278.12	300.68	333.96	359.51	225.92	282.05	343.58	299.66	274.39	228.05	201.11
Feb	190.09	181.23	190.80	216.36	260.33	284.30	299.82	328.25	358.13	220.32	281.55	334.50	343.36	314.40	261.31	230.44
Mar	194.23	185.17	194.95	221.06	265.99	290.48	358.43	378.41	390.36	250.60	333.46	411.72	337.12	308.69	256.55	226.25
Apr	202.49	193.05	203.24	230.47	277.30	302.85	325.35	358.36	409.05	240.57	318.55	386.43	330.88	302.97	251.80	222.06
May	204.56	195.02	205.32	232.82	280.13	305.94	354.39	374.23	400.38	242.27	317.50	400.28	324.63	297.25	247.05	217.87
Jun	208.69	198.96	209.47	237.53	285.79	312.12	360.53	382.51	411.07	264.15	333.86	402.08	318.39	291.54	242.30	213.68
Jul	210.76	200.93	211.54	239.88	288.62	315.21	342.40	383.18	431.23	274.67	334.36	399.95	315.27	288.68	239.93	211.58
Aug	214.89	204.87	215.69	244.58	294.28	321.39	345.13	372.80	379.80	251.92	320.03	395.23	309.03	282.96	235.18	207.39
Sep	219.02	208.81	219.84	249.29	299.94	327.57	367.08	389.69	398.27	288.97	346.85	403.71	305.90	280.10	232.80	205.30
Oct	223.15	212.75	223.98	253.99	305.60	333.75	370.44	428.05	378.56	307.18	361.44	397.02	293.42	268.67	223.30	196.92
Nov	227.29	216.69	228.13	258.69	311.26	339.93	380.25	431.90	314.22	310.43	364.75	399.98	287.18	262.96	218.55	192.73
Dec	198.36	189.11	199.10	225.77	271.64	296.66	364.05	395.76	293.80	279.36	360.84	388.19	280.93	257.24	213.80	188.54

Data Source: UNCTAD database

A-12 Monthly transport volume of grain (10^6 tons)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	21.55	22.05	24.78	21.14	21.61	25.02	24.95	23.37	29.57	24.44	28.24	25.86	36.82	32.05	37.90	33.58
Feb	20.76	22.40	23.41	19.43	20.65	22.08	20.93	23.03	27.50	24.72	24.52	27.11	37.11	29.79	37.26	33.96
Mar	24.16	24.36	26.50	22.00	23.80	25.39	25.38	23.24	27.56	32.42	29.52	33.73	32.89	33.12	37.34	40.14
Apr	21.99	23.46	25.66	21.98	22.02	23.45	23.96	24.75	27.25	31.16	29.63	33.90	31.83	32.08	36.92	42.81
May	23.34	23.61	23.96	23.64	23.00	23.27	27.79	24.66	27.46	27.95	32.06	34.17	29.45	36.40	37.22	38.40
Jun	20.94	20.27	21.48	21.65	20.92	21.12	22.32	23.21	22.99	27.37	29.77	28.53	30.99	33.79	31.15	37.60
Jul	20.27	20.47	20.40	22.06	23.16	21.06	23.03	23.35	28.17	26.00	30.00	26.35	28.62	34.06	38.17	35.73
Aug	22.53	22.87	21.80	23.68	23.94	21.68	26.48	29.55	28.61	25.94	28.26	27.57	29.94	32.07	38.76	35.65
Sep	23.64	20.75	19.58	24.21	24.35	21.36	24.59	29.78	28.19	27.16	31.23	26.75	30.93	31.55	38.20	37.33
Oct	20.82	20.80	20.31	23.84	21.66	24.95	25.04	28.14	27.03	22.71	27.24	24.89	27.03	30.93	36.63	31.21
Nov	20.43	21.65	20.39	22.39	23.47	21.41	23.44	27.13	22.95	22.41	26.16	27.43	29.80	29.69	31.10	35.20
Dec	20.86	20.95	20.99	25.64	24.15	23.71	24.50	25.59	21.54	28.63	26.56	28.91	29.53	34.05	31.34	39.34

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-13 Monthly transport volume of iron ore (10^6 tons)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	38.42	34.74	38.19	43.33	44.08	51.80	59.55	70.91	71.72	54.65	84.57	74.45	106.57	101.45	100.71	96.81
Feb	35.99	36.62	32.00	40.28	50.18	47.24	53.33	56.40	69.88	69.17	72.33	67.14	112.68	98.84	101.57	105.23
Mar	36.66	37.97	39.38	41.33	51.91	60.73	61.43	69.10	67.98	72.77	81.76	83.04	99.83	96.16	110.29	110.70
Apr	37.39	38.72	43.51	41.82	51.93	56.56	57.33	66.78	76.65	80.43	74.28	79.52	100.47	108.42	100.20	122.36
May	41.37	39.11	39.82	45.37	41.37	53.40	55.32	60.16	72.00	76.78	76.55	85.91	97.88	101.84	103.26	116.81
Jun	36.04	33.27	35.32	42.36	45.13	52.24	61.00	56.87	71.89	78.55	81.14	83.70	93.10	101.69	109.45	119.50
Jul	38.77	40.55	42.29	42.96	51.90	51.65	55.10	66.39	74.29	84.64	79.70	88.28	89.49	105.09	114.19	128.77
Aug	41.06	38.31	41.71	40.31	45.73	57.56	67.14	62.56	69.90	76.33	85.58	100.00	88.27	98.88	115.45	116.13
Sep	34.86	37.39	42.90	45.94	53.44	54.52	53.68	65.36	72.98	94.99	85.38	95.27	87.57	103.23	115.17	130.84
Oct	35.28	38.34	42.95	41.36	46.97	53.92	56.76	64.65	64.72	73.94	92.01	93.86	83.87	91.54	124.12	112.48
Nov	37.26	38.22	41.83	42.34	51.41	63.01	60.74	69.77	63.00	64.83	80.85	94.66	79.62	89.11	109.06	98.62
Dec	37.07	39.04	40.31	48.32	58.52	59.36	71.75	68.07	65.93	71.20	97.28	106.84	70.81	93.25	131.22	108.32

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-14 Monthly transport volume of coal (10^6 tons)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	40.89	49.43	48.24	51.62	49.96	57.28	64.88	60.75	61.02	60.93	73.78	105.27	105.27	93.51	93.33	94.35
Feb	39.48	41.82	43.69	47.22	47.44	52.21	53.15	57.82	53.96	56.58	65.42	106.91	106.91	82.91	82.54	78.46
Mar	43.16	42.54	49.21	50.09	53.60	53.83	59.56	63.05	65.54	62.31	68.87	105.38	105.38	87.29	100.24	92.72
Apr	39.73	47.87	45.08	49.78	56.30	59.79	58.43	66.10	67.58	59.41	77.55	106.23	106.23	98.29	103.37	93.07
May	41.52	48.50	46.21	48.78	56.58	58.87	63.53	63.21	67.60	57.66	80.12	92.04	92.04	101.55	103.40	87.11
Jun	41.71	46.40	47.81	47.97	54.50	56.73	59.02	61.17	66.22	75.64	79.41	100.25	100.25	100.66	101.29	99.10
Jul	44.04	47.15	43.09	48.55	51.95	56.00	59.75	63.84	62.60	72.03	78.05	93.94	93.94	98.93	95.74	93.29
Aug	45.65	46.85	48.97	49.71	56.88	54.16	58.68	64.60	68.19	66.14	80.02	86.72	86.72	101.42	104.30	105.76
Sep	43.81	44.71	45.45	49.82	51.44	56.42	61.52	65.44	71.99	75.72	81.70	82.69	82.69	103.55	110.11	100.22
Oct	43.68	44.93	46.49	53.45	56.25	59.79	60.05	63.62	72.53	76.33	83.57	78.74	78.74	105.92	110.94	101.59
Nov	41.27	41.74	43.39	50.87	51.65	49.70	60.79	66.14	70.04	67.50	78.43	80.25	80.25	99.41	107.13	100.95
Dec	42.67	44.47	49.81	52.53	56.32	58.35	65.50	72.44	65.50	76.82	83.55	84.80	84.80	105.89	100.18	102.50

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-15 Monthly transport volume of crude oil (10^6 tons)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	19.45	21.00	19.64	20.01	21.05	21.45	21.04	20.43	21.37	18.19	21.45	22.25	19.03	16.61	18.70	17.16
Feb	19.46	20.84	20.14	20.05	21.02	21.29	21.16	21.30	20.75	19.61	21.58	23.16	17.22	16.79	17.99	18.08
Mar	19.36	19.96	19.36	20.31	20.70	21.56	21.50	19.99	20.99	18.63	21.53	23.62	21.12	17.87	19.49	16.85
Apr	19.82	20.69	19.61	20.24	20.99	21.04	20.65	21.11	20.87	18.44	21.58	23.01	18.52	17.43	18.09	16.34
May	20.01	20.64	19.66	20.53	20.75	21.67	20.43	20.32	20.62	18.60	21.58	22.82	18.37	19.85	16.75	17.24
Jun	19.18	19.69	19.87	20.93	20.95	20.85	20.63	20.99	19.69	17.81	21.28	23.38	18.34	17.78	17.32	17.27
Jul	19.97	19.60	19.93	20.82	22.19	21.99	21.90	21.36	21.28	18.52	21.57	24.29	20.43	19.26	17.93	16.71
Aug	20.74	20.90	19.96	20.66	21.27	21.72	21.38	19.91	20.94	21.08	21.44	24.44	18.36	17.28	17.00	16.67
Sep	20.21	20.33	20.04	20.56	21.87	21.77	21.26	19.47	21.19	21.02	21.52	24.35	16.32	18.81	16.21	15.76
Oct	20.52	20.71	18.94	20.96	20.81	20.58	21.37	20.25	19.02	21.28	21.62	24.14	16.80	18.72	18.20	15.99
Nov	20.28	20.29	20.37	20.81	21.91	20.65	21.27	19.47	20.59	21.33	21.20	24.48	19.01	17.56	18.09	16.52
Dec	20.34	20.44	21.41	20.98	21.13	21.67	21.29	21.53	20.12	21.36	22.10	18.22	19.29	19.43	16.71	15.94

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-16 Monthly transport volume of container (10^6 TEU)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	5.70	5.28	6.55	6.54	7.08	8.94	9.26	10.13	10.95	9.17	11.04	12.74	12.74	13.86	12.90	12.43
Feb	5.34	5.57	5.93	6.01	8.06	8.15	8.85	9.24	10.08	9.61	9.79	11.78	11.78	13.50	13.01	13.51
Mar	5.44	5.77	6.68	6.81	8.34	8.40	10.20	11.88	11.29	11.96	10.30	13.16	13.16	13.13	14.13	14.21
Apr	5.55	5.89	6.12	6.80	8.35	9.33	9.44	11.06	11.08	12.02	11.60	14.73	14.73	14.81	12.83	15.71
May	6.14	5.95	6.27	7.32	6.65	9.19	9.85	10.45	10.70	12.12	11.99	14.85	14.85	13.91	13.22	14.99
Jun	5.35	5.06	6.49	6.70	7.25	8.86	8.96	10.22	11.19	10.12	11.88	12.40	12.40	13.89	14.02	15.34
Jul	5.75	6.16	5.85	6.83	8.34	8.74	9.93	10.10	11.33	9.34	11.68	11.45	11.45	14.35	14.62	16.53
Aug	6.09	5.82	6.65	7.33	7.35	8.46	10.26	11.26	11.13	9.77	11.97	11.98	11.98	13.51	14.79	14.91
Sep	5.17	5.68	6.17	7.49	8.59	8.81	10.44	10.67	11.66	9.49	12.23	12.37	12.37	14.10	14.75	16.80
Oct	5.23	5.83	6.31	7.38	7.55	9.33	9.28	10.55	11.39	8.83	12.50	10.81	10.81	12.50	15.90	14.44
Nov	5.53	5.81	5.89	6.93	8.26	7.76	10.06	12.33	11.53	9.73	11.74	11.92	11.92	12.17	13.97	12.66
Dec	5.50	5.94	6.76	7.94	9.41	9.11	10.35	11.61	12.42	10.25	12.50	11.81	11.81	12.74	16.81	13.91

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-17 Monthly average of BCI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	1715.85	2075.86	1050.55	2273.95	7599.05	6054.00	2976.14	6225.55	9668.55	1775.67	4041.00	1654.00	1846.00	1441.00	2171.00	627.00
Feb	1843.00	1878.35	1174.55	2283.35	7247.20	6318.20	3645.05	6319.60	9731.45	3178.95	3367.00	1375.00	1468.00	1398.00	1674.00	612.00
Mar	2220.87	1835.32	1345.90	2538.57	6231.35	6022.95	3680.91	7236.86	11251.68	2441.86	3591.00	1682.00	1450.00	1275.00	2766.00	439.00
Apr	2308.28	1744.26	1333.10	2721.55	5324.75	6347.05	3345.56	8362.95	12065.50	2206.00	3286.00	1608.00	1519.00	1237.00	1887.00	508.00
May	2130.90	1792.00	1165.24	2952.35	4296.47	5065.90	3095.00	9192.24	16808.10	3724.63	4626.00	1602.00	1536.00	1347.00	1773.00	782.00
Jun	2055.77	1751.48	1167.56	2891.71	3911.36	3077.77	3388.73	7616.10	15815.33	7225.91	3793.00	1876.00	1187.00	1637.00	1768.00	1043.00
Jul	2144.05	1466.59	1128.78	2852.61	5108.82	2942.90	3987.29	8439.32	13221.26	5628.26	1969.00	1941.00	1316.00	1986.00	1451.00	1632.00
Aug	2227.50	1106.68	1150.90	3202.25	5950.62	3003.86	5134.36	9736.09	11665.05	4400.15	2986.00	2054.00	1154.00	2069.00	1854.00	1890.00
Sep	2326.57	1030.70	1459.95	3548.36	5565.18	3999.77	5346.62	11855.70	6740.73	3232.18	3609.00	3128.00	1342.00	3467.00	2306.00	1547.00
Oct	2453.77	1013.74	1776.30	6166.91	5992.05	4694.43	5410.82	14855.39	2489.91	4162.55	4163.00	3391.00	2104.00	3294.00	2085.00	1516.00
Nov	2518.45	966.45	1887.19	6231.05	7425.55	4365.73	5733.59	15171.32	1028.45	6617.76	3656.00	3065.00	2280.00	2494.00	3149.00	883.00
Dec	2276.21	981.82	2217.47	6570.06	7649.44	3490.18	5871.63	14634.19	1172.22	5296.11	2711.00	3516.00	1584.00	3843.00	971.00	718.00

Data Source: Baltic Exchange

A-18 Monthly average of BPI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	1396.00	1611.00	988.22	1731.00	4988.00	4361.00	2154.00	4286.00	6954.00	551.43	3823.00	1732.00	1183.00	719.00	1550.00	722.00
Feb	1356.00	1569.00	969.00	1657.00	5265.00	4394.00	2179.00	4245.00	6743.00	1332.00	3155.00	1672.00	862.00	807.00	1266.00	487.00
Mar	1548.00	1621.00	1058.00	1763.00	5285.00	4774.00	2419.00	4989.00	8149.00	1824.00	4024.00	2048.00	954.00	1147.00	1077.00	593.00
Apr	1528.00	1534.00	1043.00	2044.00	5285.00	4162.00	2223.00	5390.00	8330.00	1407.00	3885.00	1598.00	1325.00	1123.00	828.00	636.00
May	1541.00	1497.00	1067.00	2218.00	3543.00	3270.00	2283.00	6016.00	10144.00	2293.00	4305.00	1733.00	1287.00	930.00	950.00	576.00
Jun	1597.00	1371.00	972.00	2053.00	2672.00	2767.00	2678.00	5787.00	9324.00	3015.00	3342.00	1828.00	997.00	865.00	587.00	725.00
Jul	1606.00	1253.00	1000.00	2222.00	3641.00	1927.00	2912.00	7101.00	8715.00	3194.00	2242.00	1585.00	1115.00	1084.00	615.00	1058.00
Aug	1583.00	957.00	1008.00	2130.00	3863.00	2001.00	3393.00	7163.00	6470.00	2435.00	2857.00	1558.00	832.00	941.00	732.00	1032.00
Sep	1646.00	960.50	1182.00	2273.00	3953.00	2483.00	3946.00	8828.00	4943.00	2459.00	2994.00	1682.00	526.00	1335.00	861.00	775.00
Oct	1608.00	887.78	1285.00	4100.00	4425.00	2729.00	3811.00	10631.00	1417.00	2770.00	2333.00	1968.00	756.00	1937.00	993.00	712.00
Nov	1555.00	841.05	1410.00	4053.00	5144.00	2414.00	4089.00	10616.00	835.25	3899.00	2270.00	1806.00	864.00	1495.00	1123.00	528.00
Dec	1497.00	863.59	1650.00	4461.00	5285.00	2373.00	4272.00	9395.00	515.00	3660.00	2194.00	1726.00	858.00	1921.00	1005.00	429.00

Data Source: Baltic Exchange

A-19 Monthly average of BDI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	1370.55	1565.95	931.32	1693.86	5229.48	4501.90	2261.76	4461.68	7169.82	904.52	3168.35	1401.00	1039.00	771.00	1472.00	725.00
Feb	1392.95	1479.15	959.55	1673.70	5450.05	4532.25	2443.70	4397.75	6874.24	1815.85	2677.85	1181.00	703.00	745.00	1140.00	539.00
Mar	1620.70	1501.59	1064.75	1849.76	5131.17	4677.90	2598.83	5123.14	8062.58	1957.82	3206.83	1493.00	859.00	876.00	1484.00	576.00
Apr	1667.11	1440.11	1077.43	2063.55	4488.80	4532.48	2465.44	5753.68	8286.86	1659.15	3043.10	1343.00	1021.00	874.00	1045.00	591.00
May	1602.43	1448.29	1032.91	2231.20	3595.68	3667.40	2441.86	6402.24	10843.65	2539.84	3838.05	1352.00	1101.00	851.00	991.00	597.00
Jun	1588.64	1377.48	995.06	2135.90	2901.59	2746.09	2718.45	5772.14	10245.10	3822.55	3088.00	1433.00	937.00	941.00	912.00	699.00
Jul	1618.38	1221.36	988.57	2191.91	3778.41	2220.10	3049.81	6572.14	8935.74	3361.87	1909.73	1366.00	1056.00	1123.00	796.00	975.00
Aug	1639.36	979.91	1001.76	2285.95	4169.00	2202.77	3686.73	7195.09	7402.50	2684.65	2432.33	1387.00	761.00	1088.00	937.00	1066.00
Sep	1711.52	945.65	1182.38	2462.86	4140.77	2803.18	4039.14	8585.90	4975.09	2357.64	2719.45	1840.00	707.00	1681.00	1123.00	889.00
Oct	1734.32	898.04	1365.39	4162.57	4539.43	3161.43	4027.64	10425.91	1807.52	2745.68	2693.33	2072.00	952.00	1883.00	1101.00	793.00
Nov	1722.45	855.23	1460.43	4250.40	5308.91	2915.50	4190.09	10542.68	818.95	3940.57	2321.32	1835.00	1025.00	1559.00	1332.00	582.00
Dec	1609.37	870.18	1665.94	4609.00	5518.83	2600.00	4335.81	9854.13	743.00	3572.39	2031.00	1869.00	856.00	2178.00	910.00	519.00

Data Source: Baltic Exchange

A-20 Monthly average of BDTI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	991.00	1776.00	800.59	1528.00	2113.00	1521.00	1683.00	1235.00	1396.00	717.86	1125.70	714.00	811.00	647.00	1125.00	909.00
Feb	1143.00	1474.00	714.40	1744.00	1670.00	1493.00	1383.00	1168.00	1091.00	589.85	943.60	741.00	798.00	659.00	812.00	867.00
Mar	1286.00	1678.00	693.70	1981.00	1423.00	1543.00	1149.00	1158.00	1325.00	635.41	968.43	1004.00	823.00	672.00	698.00	812.00
Apr	1282.00	1345.00	741.29	1317.00	1155.00	1217.00	1021.00	1178.00	1539.00	480.20	958.75	858.00	779.00	655.00	679.00	784.00
May	1428.00	1110.00	788.77	1224.00	1254.00	1358.00	1179.00	1197.00	1939.00	477.84	1047.47	786.00	754.00	614.00	662.00	827.00
Jun	1605.00	926.00	750.44	881.52	1454.00	1225.00	1252.00	1034.00	1943.00	612.91	911.18	744.00	678.00	591.00	671.00	961.00
Jul	1759.00	978.14	742.91	881.52	1488.00	1169.00	1428.00	1044.00	2072.00	516.48	824.50	740.00	640.00	621.00	830.00	842.00
Aug	1854.00	1003.00	663.76	783.95	1360.00	1047.00	1453.00	857.09	1510.00	485.25	772.86	699.00	617.00	637.00	768.00	661.00
Sep	1735.00	1019.00	673.00	1012.00	1402.00	1275.00	1278.00	848.85	1498.00	512.05	689.00	685.00	637.00	589.00	639.00	658.00
Oct	2083.00	996.00	925.00	1088.00	2678.00	1975.00	1294.00	944.00	1377.00	565.22	730.86	800.00	669.00	600.00	700.00	760.00
Nov	2158.00	776.45	1191.00	1461.00	3050.00	2198.00	1098.00	1110.00	1065.00	639.38	818.41	778.00	699.00	643.00	887.00	862.00
Dec	2263.00	811.88	1350.00	1888.00	2364.00	2110.00	1205.00	1934.00	1280.00	753.44	1020.00	847.00	737.00	815.00	851.00	917.00

Data Source: Baltic Exchange

A-21 Monthly average of CTRI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	70.97	80.80	47.81	62.04	103.50	169.02	110.69	95.88	113.24	44.70	32.25	66.00	40.00	42.00	47.00	47.00
Feb	77.55	82.07	49.32	71.07	112.71	170.54	107.28	100.38	112.79	40.49	34.38	71.00	40.00	42.00	47.00	48.00
Mar	80.63	82.63	51.30	74.78	119.55	171.84	106.77	101.97	112.90	37.46	36.13	76.00	41.00	43.00	47.00	50.00
Apr	86.03	81.96	55.78	79.35	124.40	171.84	110.81	103.46	110.80	35.27	41.46	75.00	42.00	43.00	47.00	52.00
May	90.35	79.32	57.43	84.87	126.15	169.79	113.16	105.27	108.05	34.93	46.80	75.00	43.00	45.00	47.00	59.00
Jun	90.70	75.65	56.58	88.38	128.42	164.22	112.41	106.63	101.19	33.92	57.91	73.00	45.00	46.00	47.00	63.00
Jul	90.70	71.87	59.48	92.73	130.84	159.39	111.62	108.56	96.62	33.63	61.00	65.00	45.00	47.00	47.00	62.00
Aug	90.45	65.78	63.70	94.58	135.85	150.35	107.97	112.27	91.83	33.51	64.00	61.00	44.00	47.00	47.00	60.00
Sep	89.94	59.25	62.10	96.71	141.78	142.31	104.66	115.58	87.37	33.30	64.00	55.00	44.00	48.00	47.00	55.00
Oct	89.67	54.89	63.00	95.07	145.88	123.76	98.62	116.35	65.06	33.00	61.00	48.00	44.00	47.00	47.00	51.00
Nov	85.26	48.85	61.53	95.48	154.38	114.10	94.08	114.35	57.58	32.00	57.00	46.00	43.00	48.00	47.00	46.00
Dec	83.34	46.80	58.81	94.17	163.37	115.60	91.40	113.52	46.64	32.00	59.00	42.00	42.00	47.00	47.00	45.00

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-22 Monthly average price of 380cst Singapore

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	138.38	121.38	112.00	181.20	168.30	181.00	307.13	274.88	469.38	256.10	484.20	541.00	732.00	634.13	612.60	289.50
Feb	143.75	128.38	118.63	199.75	168.63	196.75	318.50	296.38	466.00	261.75	460.38	617.63	732.75	655.25	617.88	354.13
Mar	170.30	134.30	131.80	191.63	163.75	224.88	331.00	314.90	498.00	248.75	462.25	640.13	733.30	636.90	606.13	332.63
Apr	158.88	143.50	147.63	168.88	171.40	261.40	346.05	340.88	523.50	290.25	481.30	666.90	721.75	617.38	589.75	330.00
May	167.00	149.88	155.50	164.00	188.75	259.88	345.88	340.00	583.20	342.30	456.38	639.50	672.25	604.10	594.60	375.70
Jun	171.00	134.50	149.50	167.00	182.38	257.38	327.10	348.80	630.00	402.38	440.00	656.13	592.60	600.75	601.63	361.50
Jul	150.88	133.13	158.88	178.63	180.90	256.50	341.00	384.00	720.25	407.90	438.80	665.90	614.38	595.50	595.75	308.50
Aug	147.88	141.20	166.80	167.10	191.25	272.38	322.50	372.30	687.30	443.88	447.50	651.75	657.70	601.20	594.20	249.75
Sep	170.30	147.38	172.50	161.38	186.25	321.30	291.60	389.88	604.38	433.63	440.25	659.70	663.00	605.38	574.75	239.38
Oct	181.88	129.00	160.75	161.20	202.30	319.25	286.63	435.88	416.60	440.60	466.20	667.25	637.63	618.38	497.10	239.70
Nov	169.38	108.80	149.20	160.50	190.75	303.00	271.13	498.60	232.88	471.88	488.50	686.25	605.00	610.60	465.75	227.75
Dec	135.00	117.25	164.13	163.25	169.20	289.10	269.70	477.38	236.00	463.00	503.90	671.20	606.38	611.63	366.00	190.63

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-23 Monthly average price of 380cst Rotterdam

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	127.50	106.25	104.50	173.50	141.40	157.50	282.88	229.13	447.75	225.70	457.20	514.75	682.38	608.75	570.40	250.10
Feb	133.88	121.50	103.25	175.13	139.00	171.25	294.75	251.50	436.90	239.13	445.50	575.25	694.63	634.50	580.00	304.63
Mar	147.30	119.80	120.50	148.25	144.50	203.00	300.30	272.70	477.38	247.83	453.25	606.38	712.60	605.60	574.50	301.88
Apr	125.50	116.75	136.13	126.38	152.60	231.90	320.13	312.00	494.88	276.25	467.00	641.60	697.00	584.00	578.75	307.25
May	126.50	122.00	140.80	137.90	170.63	230.13	324.63	325.88	542.90	327.50	437.38	621.75	651.50	580.20	576.40	343.70
Jun	144.30	121.60	135.00	147.50	159.50	232.25	301.40	325.90	593.76	384.25	424.38	631.25	572.40	580.00	590.25	328.50
Jul	132.88	118.00	142.75	170.50	162.90	248.90	316.50	359.88	679.50	382.80	423.70	647.50	597.13	596.75	575.00	292.70
Aug	132.50	125.50	145.90	159.70	167.00	261.75	311.00	353.70	635.60	429.38	439.63	634.38	640.50	601.60	563.40	233.75
Sep	154.50	130.13	161.38	147.75	161.75	288.40	280.50	374.00	544.13	412.38	431.50	640.50	640.00	597.50	547.50	226.63
Oct	159.88	110.63	154.00	151.90	173.90	270.50	266.13	412.50	398.00	423.10	458.60	633.00	616.75	588.50	481.60	222.50
Nov	149.75	101.90	125.70	154.75	146.50	256.38	262.38	476.10	217.63	462.00	476.00	645.13	588.00	575.90	420.00	201.00
Dec	126.70	103.75	134.38	141.00	143.50	255.80	255.90	447.50	194.50	438.75	488.60	623.80	582.75	584.25	327.88	157.13

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-24 Monthly average price of MDO Singapore

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	208.63	241.88	157.63	250.70	290.10	366.25	525.00	490.25	788.38	477.10	625.00	802.50	972.13	939.75	928.60	560.80
Feb	229.50	208.75	159.88	288.25	282.00	379.63	502.50	519.50	815.20	377.00	613.75	881.00	1000.88	978.25	921.88	585.38
Mar	247.60	199.70	175.80	282.25	281.38	461.88	529.20	537.80	940.50	388.50	648.00	968.50	1014.60	921.60	917.88	623.38
Apr	213.88	222.50	202.50	232.00	287.70	486.00	615.00	587.38	1041.50	439.75	695.40	1007.20	996.75	890.00	918.75	593.25
May	219.63	227.00	210.10	213.10	315.63	446.75	633.75	597.75	1192.90	470.20	655.75	957.88	948.00	882.00	912.60	599.20
Jun	234.30	219.20	211.50	215.88	305.00	485.63	638.50	605.80	1235.75	571.75	634.75	946.63	841.20	888.13	840.88	571.25
Jul	237.75	217.13	207.25	216.25	326.50	511.00	644.38	623.13	1268.38	530.00	638.50	963.20	884.75	905.63	905.88	521.40
Aug	274.50	216.50	209.80	229.30	371.25	525.00	645.00	617.40	1034.60	597.75	649.75	922.25	955.80	911.00	886.50	444.50
Sep	315.90	219.25	211.00	236.38	372.50	576.00	645.00	670.63	919.50	566.25	638.25	926.00	972.75	907.13	857.63	434.75
Oct	301.25	194.50	226.25	236.40	415.00	558.75	530.00	708.00	679.10	566.80	688.40	911.00	956.75	895.00	800.80	430.60
Nov	272.00	169.70	226.30	249.13	398.75	498.13	527.50	789.80	520.50	627.25	715.75	969.38	930.20	906.00	738.13	386.38
Dec	226.60	158.25	235.75	260.00	366.00	482.00	528.30	714.63	447.75	602.00	766.50	939.20	925.25	932.50	652.88	343.38

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-25 Monthly average price of MDO Rotterdam

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	199.00	218.50	153.88	245.50	253.60	350.00	489.38	441.88	733.75	421.70	608.30	811.25	959.25	949.75	910.70	542.90
Feb	210.13	210.50	148.25	270.13	237.50	375.00	477.75	458.75	767.50	365.63	587.25	886.00	992.00	993.50	903.98	567.48
Mar	218.00	200.00	163.40	272.63	260.00	453.88	510.50	489.50	879.38	370.00	615.00	890.75	1016.20	906.60	899.98	605.48
Apr	205.50	199.00	180.38	210.50	263.60	449.00	565.63	521.50	951.63	411.63	675.60	1028.20	1009.25	888.25	900.85	575.35
May	210.50	197.75	182.40	204.00	291.00	405.00	571.25	521.38	1096.50	441.50	666.75	946.50	953.25	864.10	894.70	581.30
Jun	217.90	196.70	184.63	206.75	286.00	457.50	563.00	547.60	1125.00	538.75	651.75	965.50	852.20	870.23	822.98	553.35
Jul	223.50	188.88	191.25	211.75	308.20	475.80	575.00	580.63	1133.13	500.70	654.20	965.20	884.25	887.73	887.98	503.50
Aug	236.00	189.60	202.80	225.30	341.50	509.38	576.25	555.50	999.80	565.88	663.50	931.25	957.80	893.10	868.60	426.60
Sep	274.90	200.13	216.75	207.63	348.63	571.00	519.00	609.50	886.88	537.13	666.25	939.60	977.75	889.23	839.73	416.85
Oct	274.75	176.50	217.38	225.20	425.70	535.63	479.38	631.25	684.00	559.00	718.20	929.00	992.25	877.10	782.90	412.70
Nov	263.50	160.60	198.40	236.63	386.25	464.38	475.13	741.50	532.50	599.00	726.75	974.50	930.80	888.10	720.23	368.48
Dec	245.00	151.88	219.38	248.50	358.50	454.50	486.50	756.25	418.75	576.13	771.60	932.60	921.25	914.60	634.98	325.48

Data Source: Shipping Intelligence Network-Clarkson Research Service Ltd.

A-26 Monthly average brent price of crude oil

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	25.48	25.66	19.48	31.50	33.03	44.06	62.61	53.32	94.47	41.81	72.32	96.86	111.80	111.35	108.83	49.69
Feb	27.82	27.42	20.37	33.16	30.61	44.97	60.87	56.55	95.72	43.27	73.43	104.60	119.79	115.30	109.74	60.57
Mar	27.25	24.44	23.68	28.63	33.93	53.10	57.30	61.82	105.11	46.30	78.69	114.59	124.11	107.43	106.54	58.47
Apr	22.63	25.67	25.52	25.32	32.96	52.26	70.07	67.58	108.61	50.21	83.76	123.91	117.18	100.61	109.07	64.75
May	27.57	28.39	24.17	26.25	37.69	48.54	70.06	67.77	122.44	55.68	76.27	114.90	107.98	101.47	110.72	62.58
Jun	29.79	27.77	25.58	27.65	35.83	53.69	68.53	70.58	132.54	66.14	74.61	115.85	91.23	103.39	114.29	60.65
Jul	28.44	24.62	25.33	30.27	37.24	57.22	73.67	76.31	137.19	64.81	75.75	117.95	104.18	108.40	105.39	52.69
Aug	30.10	25.71	27.33	29.89	43.38	63.20	74.50	71.39	116.93	72.42	73.78	109.93	113.02	111.12	99.88	47.14
Sep	32.77	25.57	28.33	29.33	42.01	63.83	63.18	76.45	101.10	68.22	78.85	113.79	110.35	109.98	95.01	48.39
Oct	30.91	20.45	27.08	26.45	49.27	58.88	57.75	81.12	75.64	71.55	84.49	109.29	108.11	110.11	86.24	49.05
Nov	32.45	18.91	24.67	28.72	43.20	56.01	59.16	92.64	52.97	76.65	85.10	106.82	110.26	109.32	72.67	45.35
Dec	25.64	18.58	30.19	30.02	40.11	56.35	62.41	91.95	41.33	74.08	94.28	107.06	108.83	110.34	61.69	36.37

Data Source: LCE

A-27 Monthly average WTI of crude oil

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	27.26	29.41	19.88	32.72	34.09	45.68	64.06	54.54	94.50	40.33	75.55	90.16	100.79	93.16	94.52	47.43
Feb	29.33	29.48	20.36	34.93	34.23	47.83	62.65	58.62	93.13	39.38	75.33	87.71	100.07	96.15	101.24	50.60
Mar	29.85	27.19	23.69	34.69	36.81	54.19	61.98	60.44	104.41	45.04	80.72	100.97	107.01	92.87	100.53	47.56
Apr	25.78	27.40	26.06	29.08	36.35	53.47	68.71	63.47	108.92	50.37	83.58	107.72	103.87	92.02	101.91	54.71
May	28.94	28.62	27.43	27.41	39.17	49.91	70.85	63.73	122.14	55.77	77.41	104.44	98.61	94.74	101.75	59.33
Jun	31.88	27.57	25.25	30.49	38.53	55.32	70.62	66.12	131.59	68.63	73.73	98.25	84.70	95.74	105.37	59.85
Jul	29.97	26.36	26.86	30.91	39.72	58.49	74.24	72.12	137.62	64.82	75.86	91.44	85.45	104.66	103.33	50.17
Aug	31.32	27.41	27.99	31.33	44.76	63.84	73.67	73.20	119.00	69.43	78.30	88.93	91.99	106.55	96.27	42.52
Sep	33.86	26.88	29.36	27.30	44.71	65.82	65.11	77.06	106.61	70.75	74.15	87.38	95.63	106.51	93.11	45.47
Oct	33.02	22.26	29.44	30.32	52.54	63.11	59.42	83.36	87.93	72.62	80.37	83.45	91.14	100.41	83.55	46.07
Nov	34.38	20.17	26.43	30.74	49.37	58.82	58.60	93.97	60.58	78.56	83.83	95.64	86.09	93.93	76.64	42.84
Dec	28.47	19.07	28.71	31.78	43.99	58.92	62.03	91.27	44.27	73.75	79.22	98.25	87.46	97.81	60.01	37.05

Data Source: NYME

B. Calculation result of indicators

B-1 Indicator of monthly order volume of bulk carrier

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	44.21	46.88	31.42	41.74	73.36	90.60	100.00	139.86	324.24	420.90	420.90	400.81	305.00	183.27	224.61	230.92
Feb	45.06	44.38	28.52	45.55	74.36	102.66	105.35	146.81	341.82	422.83	422.83	397.15	292.56	178.52	237.04	221.10
Mar	45.70	43.29	28.43	47.16	74.69	103.00	105.20	154.69	351.96	422.54	422.54	394.87	284.59	176.45	240.53	213.66
Apr	46.81	40.35	27.37	49.63	78.11	102.48	108.30	166.33	363.51	419.00	419.00	384.29	269.52	172.90	240.54	205.92
May	47.67	40.77	30.98	51.91	82.46	101.43	108.62	179.34	381.50	414.18	414.18	378.06	258.06	173.05	241.56	202.33
Jun	48.20	39.20	29.98	53.71	82.84	100.88	110.34	202.38	389.74	410.62	410.62	369.29	242.28	180.73	242.69	196.33
Jul	48.22	37.29	32.72	58.90	84.27	100.87	109.23	217.08	394.57	406.74	406.74	364.27	227.62	184.21	245.34	191.66
Aug	47.94	36.57	32.73	63.08	86.26	101.27	115.27	230.84	416.86	408.47	408.47	354.56	219.16	187.51	244.39	187.14
Sep	47.79	35.78	33.69	62.29	86.39	101.37	115.22	249.84	420.59	406.28	406.28	350.45	214.05	190.12	244.51	182.99
Oct	45.99	32.69	36.60	63.46	87.51	99.54	120.67	266.12	428.17	400.33	400.33	334.57	203.34	191.17	241.73	181.51
Nov	46.44	32.66	38.65	67.72	89.07	99.04	124.16	286.24	428.24	398.33	398.33	325.88	194.80	198.39	237.05	175.82
Dec	46.31	31.58	38.86	68.22	89.10	97.36	128.12	299.05	423.58	396.01	396.01	314.70	186.50	206.68	232.12	171.05

B-2 Indicator of monthly order volume of tanker

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	27.52	25.52	28.18	64.36	40.77	70.84	100.00	83.98	79.90	23.64	15.34	17.42	24.98	39.50	55.72	58.96
Feb	30.79	39.64	4.91	72.09	50.78	20.42	93.85	58.16	27.38	2.85	39.30	6.36	9.50	56.86	48.72	83.56
Mar	34.04	48.42	21.70	68.21	20.81	12.82	272.20	75.09	53.76	8.35	19.15	6.57	14.78	21.91	53.61	32.87
Apr	66.43	42.37	30.27	48.86	51.26	28.85	99.09	53.37	121.39	0.60	57.53	21.08	8.96	49.26	23.85	28.01
May	24.63	24.28	34.65	62.15	65.90	73.76	43.83	54.45	133.41	0.00	20.85	16.80	31.96	19.59	26.14	67.53
Jun	91.65	50.21	19.68	79.01	16.67	48.14	90.07	74.80	88.85	3.23	72.46	7.25	8.55	23.79	33.46	108.67
Jul	33.32	19.39	25.66	80.40	31.72	51.12	109.73	57.11	73.26	19.15	73.60	18.23	10.78	5.07	33.56	57.24
Aug	48.66	39.19	12.72	28.10	47.65	5.50	121.84	37.76	150.47	56.41	63.94	6.78	12.07	57.56	18.22	48.98
Sep	40.60	40.14	22.55	45.00	45.40	16.90	91.69	45.87	55.63	14.26	73.10	6.82	6.51	30.07	38.69	70.08
Oct	52.33	18.22	29.80	46.31	37.22	29.81	64.70	57.40	7.01	35.28	50.32	5.38	19.44	35.58	28.77	41.41
Nov	28.57	9.19	24.13	45.01	70.84	33.03	143.61	53.23	11.47	12.00	39.54	5.20	34.50	45.81	10.15	46.22
Dec	49.07	4.72	45.64	83.36	20.42	53.03	109.78	44.47	10.70	49.15	42.14	31.10	53.91	167.78	53.64	69.12

B-3 Indicator of monthly order volume of container vessel

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	21.35	32.96	28.18	25.65	60.36	83.49	100.00	107.27	151.20	142.15	113.40	88.43	100.08	78.80	92.87	80.43
Feb	24.28	33.44	4.91	27.18	63.20	88.38	100.74	106.09	152.45	138.37	110.86	87.95	97.84	80.92	94.97	80.22
Mar	25.47	34.41	21.70	30.03	65.37	93.15	100.36	105.41	152.57	136.58	108.30	92.93	94.79	79.94	94.09	78.23
Apr	27.29	35.17	30.27	31.00	70.55	98.10	98.81	106.73	150.06	133.85	105.26	94.40	90.20	77.25	91.50	78.95
May	29.12	35.71	34.65	32.57	73.90	100.02	98.43	110.08	150.41	130.91	99.71	93.57	87.31	77.18	89.71	80.64
Jun	29.30	36.66	19.68	35.85	74.93	103.33	98.51	114.43	148.77	129.01	96.83	94.13	83.95	80.08	88.59	82.73
Jul	31.30	35.54	25.66	35.36	74.76	106.23	106.67	121.82	156.32	126.40	93.56	104.08	81.81	79.58	85.20	80.41
Aug	32.36	34.66	12.72	43.08	75.95	105.16	107.85	130.88	152.03	124.43	90.02	102.56	83.70	83.93	81.22	87.10
Sep	32.46	34.00	22.55	44.53	78.50	104.82	109.58	139.77	150.85	123.25	87.83	103.32	82.26	91.22	83.67	85.90
Oct	32.56	32.63	29.80	49.78	79.71	104.40	110.86	144.18	148.86	120.94	89.27	102.17	81.49	89.38	85.70	90.67
Nov	32.89	31.96	24.13	54.24	80.54	102.63	110.80	148.95	146.07	119.05	87.52	102.74	80.80	90.89	83.79	87.55
Dec	34.08	31.17	45.64	58.43	81.73	100.93	108.37	150.13	144.33	116.12	88.51	101.85	79.56	90.89	81.27	88.99

B-4 Indicator of capacity of bulk carrier

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	129.24	125.62	118.53	117.19	114.39	107.10	100.00	93.73	87.88	82.34	74.76	63.89	55.60	50.28	47.56	45.56
Feb	128.45	124.70	118.97	116.74	113.61	106.46	99.14	93.10	87.45	82.16	73.64	62.62	54.70	49.72	47.17	45.24
Mar	128.26	124.05	119.75	116.69	113.05	106.07	98.77	92.64	87.10	81.71	72.91	62.31	54.26	49.66	47.02	45.26
Apr	127.79	122.98	119.09	116.33	112.54	105.18	98.12	92.07	86.58	81.20	71.83	61.70	53.74	49.31	46.73	45.24
May	127.34	122.78	119.29	116.10	112.15	104.54	97.49	91.48	86.27	80.74	70.92	61.20	53.28	49.07	46.60	45.33
Jun	127.25	122.41	119.86	115.92	111.47	103.94	97.21	91.08	85.66	80.22	70.03	60.47	52.73	48.86	46.53	45.31
Jul	126.91	121.81	118.91	115.56	110.89	103.49	96.59	90.64	85.04	79.48	69.11	59.87	51.86	48.68	46.32	45.18
Aug	126.76	121.02	118.75	115.53	110.20	102.77	96.23	89.99	84.46	78.57	68.04	59.13	51.48	48.45	46.11	44.96
Sep	126.37	120.79	118.39	115.18	109.83	102.27	95.69	89.67	83.77	77.84	67.37	58.62	51.24	48.33	46.10	44.83
Oct	125.90	120.01	118.33	114.98	109.01	101.48	95.16	89.27	83.10	76.93	66.35	57.59	50.89	48.16	45.85	44.64
Nov	125.72	120.01	117.97	114.68	108.57	100.91	94.61	88.97	82.68	76.12	65.55	56.96	50.66	47.87	45.66	44.50
Dec	125.47	120.21	117.36	114.51	107.61	100.29	94.18	88.37	82.36	75.33	64.66	56.20	50.40	47.62	45.62	44.43

B-5 Indicator of capacity of tanker

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	119.32	116.56	118.53	116.70	113.19	107.10	100.00	94.63	89.29	85.11	79.04	76.06	71.91	69.23	68.03	67.10
Feb	118.91	116.37	118.97	116.16	112.47	106.46	100.07	94.13	89.63	83.89	78.69	75.36	71.36	68.81	67.87	66.85
Mar	119.52	116.24	119.75	115.39	112.31	106.07	99.43	93.90	89.24	83.36	78.64	75.15	71.31	68.56	67.86	66.76
Apr	119.36	116.02	119.09	114.55	111.85	105.18	98.85	93.08	88.90	82.58	78.16	74.67	71.19	68.31	67.84	66.66
May	119.03	115.62	119.29	113.48	111.49	104.54	98.43	92.50	88.27	81.79	78.05	74.21	70.90	68.07	67.88	66.37
Jun	118.77	115.78	119.86	114.81	111.19	103.94	98.06	92.14	87.93	81.30	77.79	74.07	70.60	67.90	67.79	66.19
Jul	118.28	116.19	118.91	114.72	110.49	103.49	97.47	91.57	87.71	80.56	77.39	73.52	70.17	67.72	67.65	65.98
Aug	118.32	115.97	118.75	114.22	110.05	102.77	96.72	90.81	87.98	79.91	76.95	73.07	69.92	67.75	67.58	65.78
Sep	117.74	115.95	118.39	114.66	109.20	102.27	96.30	90.77	87.73	79.80	76.83	72.91	69.87	67.73	67.46	65.69
Oct	116.97	115.90	118.33	114.13	108.58	101.48	95.71	90.29	87.26	79.47	76.68	72.53	69.52	67.74	67.39	65.37
Nov	116.88	116.51	117.97	114.15	108.01	100.91	95.21	89.89	86.36	79.08	76.37	72.27	69.22	67.93	67.34	65.23
Dec	116.54	117.97	117.36	113.46	107.19	100.29	95.00	89.67	85.62	79.23	76.10	71.83	69.20	68.02	67.07	65.06

B-6 Indicator of capacity of container vessels

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	183.57	166.94	149.18	135.03	123.97	112.94	100.00	85.79	75.58	66.99	63.25	57.72	53.51	50.51	47.89	44.96
Feb	182.38	165.97	147.73	134.11	123.37	112.11	98.90	84.90	74.67	66.44	62.82	57.27	53.24	50.29	47.68	44.61
Mar	182.15	164.34	146.95	133.15	122.61	111.63	97.91	84.20	73.87	65.93	62.56	57.13	52.97	50.21	47.74	44.45
Apr	180.74	163.16	144.66	132.36	121.43	110.25	96.37	82.98	72.80	65.56	61.97	56.72	52.39	49.77	47.30	44.05
May	179.92	161.83	143.72	131.15	120.58	109.17	95.52	82.05	72.04	65.13	61.31	55.94	52.07	49.45	46.85	43.81
Jun	178.30	160.71	142.58	130.20	119.95	107.89	93.92	81.09	71.32	64.91	60.86	55.30	51.63	49.15	46.72	43.49
Jul	176.23	158.58	141.33	128.57	118.67	107.05	92.72	80.44	70.50	64.59	60.26	54.96	51.25	48.82	46.38	43.09
Aug	175.62	157.10	140.06	127.76	117.50	105.72	91.60	79.23	69.44	64.54	59.16	54.63	51.12	48.54	45.94	42.74
Sep	174.13	155.61	139.48	127.09	116.77	104.51	90.38	78.41	68.85	64.32	58.74	54.36	50.98	48.42	45.80	42.41
Oct	172.08	153.74	137.89	126.23	115.78	103.38	89.28	77.62	68.29	63.94	58.29	54.17	50.77	48.06	45.65	42.13
Nov	170.48	152.28	137.10	125.85	114.95	102.37	88.24	76.90	67.63	63.71	57.98	53.98	50.70	47.94	45.44	41.85
Dec	169.25	151.09	135.98	124.63	113.77	100.97	86.91	76.10	67.27	63.46	57.95	53.76	50.54	47.85	45.19	41.68

B-7 Indicator of monthly trade value of grain

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	56.06	57.27	69.08	66.36	78.00	95.73	100.00	117.23	187.69	131.13	155.09	192.30	240.15	203.99	223.30	195.12
Feb	54.01	58.18	65.25	61.01	74.55	84.48	83.89	115.54	174.57	132.63	134.71	183.41	242.03	189.57	219.52	197.36
Mar	62.85	63.26	73.88	69.06	85.93	97.14	101.74	116.61	174.92	173.97	162.14	192.30	214.49	210.78	219.96	233.26
Apr	57.22	60.92	71.53	69.00	79.51	89.70	96.04	124.18	172.96	167.19	162.78	239.26	207.62	204.18	217.50	248.79
May	60.73	61.31	66.79	74.23	83.02	89.03	111.39	123.73	174.34	149.97	176.12	240.47	192.04	231.65	219.23	223.16
Jun	54.48	52.63	59.89	67.96	75.52	80.79	89.44	116.43	145.92	146.84	163.53	242.35	202.12	215.08	183.49	218.51
Jul	52.74	53.15	56.88	69.25	83.63	80.59	92.29	117.14	178.83	139.52	164.81	202.39	186.66	216.77	224.88	207.62
Aug	58.61	59.40	60.76	74.35	86.41	82.94	106.11	148.23	181.59	139.20	155.20	186.91	195.26	204.13	228.35	207.14
Sep	61.50	53.89	54.58	76.01	87.92	81.73	98.54	149.39	178.95	145.77	171.53	195.53	201.71	200.82	225.02	216.91
Oct	54.17	54.02	56.62	74.84	78.18	95.47	100.35	141.19	171.58	121.87	149.65	189.74	176.32	196.83	215.76	181.34
Nov	53.16	56.23	56.83	70.29	84.72	81.93	93.96	136.12	145.69	120.25	143.67	176.55	194.32	188.97	183.20	204.56
Dec	54.28	54.41	58.51	80.50	87.20	90.71	98.19	128.37	136.71	153.63	145.91	194.58	192.58	216.71	184.64	228.60

B-8 Indicator of monthly trade value of iron ore

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	28.49	24.93	28.27	34.32	45.18	79.99	100.00	133.52	203.70	123.02	322.28	385.57	432.36	423.51	413.10	262.04
Feb	26.68	26.28	23.68	31.90	51.43	72.96	89.56	106.21	198.47	155.69	275.60	347.74	457.14	412.63	343.35	246.23
Mar	27.18	27.25	29.14	32.73	53.21	93.78	103.16	130.13	193.08	163.79	311.56	430.05	405.03	401.43	390.75	246.25
Apr	27.72	27.79	32.20	33.12	53.22	87.34	96.27	125.76	217.71	181.03	283.04	411.86	407.63	452.64	362.57	242.27
May	30.68	28.07	29.47	35.93	42.40	82.47	92.90	113.28	204.49	172.82	291.70	444.92	397.11	425.15	363.44	231.28
Jun	26.72	23.88	26.14	33.55	46.26	80.67	102.44	107.08	204.19	176.81	309.20	433.49	377.70	424.53	359.49	220.37
Jul	28.75	29.10	31.29	34.03	53.19	79.76	92.52	125.01	211.01	190.52	303.69	457.19	363.06	438.70	344.58	227.91
Aug	30.44	27.50	30.87	31.92	46.87	88.89	112.75	117.81	198.54	171.82	326.12	517.90	358.12	412.78	325.07	229.93
Sep	25.85	26.83	31.74	36.38	54.78	84.20	90.15	123.08	207.28	213.81	325.34	493.42	355.28	430.95	315.43	204.96
Oct	26.16	27.52	31.78	32.76	48.14	83.27	95.32	121.74	183.82	166.42	350.63	486.13	340.25	382.17	347.21	195.66
Nov	27.63	27.43	30.96	33.54	52.69	97.31	101.99	131.39	178.92	145.92	308.09	490.27	323.04	371.99	319.77	197.98
Dec	27.49	28.02	29.83	38.27	59.98	91.66	120.48	128.17	187.24	160.27	370.68	553.35	287.28	389.29	317.06	200.95

B-9 Indicator of monthly trade value of coal

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	34.01	39.62	39.62	60.25	125.52	100.99	100.00	113.01	203.59	57.37	128.35	134.85	138.10	102.15	93.19	75.03
Feb	32.83	33.52	33.52	55.12	119.20	92.06	81.93	107.56	180.05	53.26	113.80	127.69	140.26	90.57	82.42	66.50
Mar	35.89	34.10	34.10	58.47	134.67	94.90	91.80	117.30	218.68	58.67	119.80	150.90	138.25	95.35	100.10	73.73
Apr	33.04	38.37	38.37	58.11	141.46	105.42	90.05	122.98	225.50	55.94	134.91	151.46	139.36	107.37	103.22	74.01
May	34.53	38.88	38.88	56.94	142.16	103.80	97.92	117.60	225.57	54.29	139.37	141.76	120.75	110.93	103.25	69.27
Jun	34.69	37.19	37.19	55.99	136.93	100.03	90.97	113.80	220.95	71.21	138.15	161.28	131.52	109.95	101.14	78.80
Jul	36.63	37.80	37.80	56.66	130.52	98.74	92.10	118.76	208.86	67.82	135.78	151.82	123.24	108.07	95.60	78.29
Aug	37.96	37.55	37.55	58.02	142.92	95.50	90.45	120.18	227.52	62.27	139.20	172.13	113.77	110.79	104.15	84.10
Sep	36.43	35.84	35.84	58.15	129.24	99.47	94.82	121.75	240.20	71.29	142.13	163.10	108.48	113.12	109.95	79.70
Oct	36.33	36.01	36.01	62.39	141.31	105.42	92.56	118.35	242.02	71.86	145.37	165.33	103.30	115.70	110.79	80.78
Nov	34.32	33.45	33.45	59.38	129.76	87.62	93.69	123.05	233.70	63.55	136.44	164.30	105.28	108.59	106.98	80.28
Dec	35.49	35.64	35.64	61.31	141.50	102.88	100.96	134.77	218.55	72.33	145.34	185.52	111.25	115.67	100.04	73.29

B-10 Indicator of monthly trade value of crude oil

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	39.51	36.18	36.15	44.30	59.26	84.63	100.00	126.34	170.91	132.56	165.50	201.60	264.05	231.05	233.55	145.53
Feb	40.39	36.98	36.95	45.28	60.58	86.51	99.71	124.19	170.25	129.26	165.20	196.27	238.93	233.55	248.57	137.29
Mar	41.27	37.78	37.75	46.27	61.90	88.39	119.20	143.16	185.57	147.04	195.66	241.58	293.05	248.57	242.45	127.95
Apr	43.03	39.39	39.36	48.24	64.53	92.16	108.20	135.58	194.46	141.16	186.91	226.74	256.97	242.45	276.12	124.08
May	43.47	39.79	39.76	48.73	65.19	93.10	117.86	141.58	190.34	142.15	186.29	234.87	254.89	276.12	247.32	130.91
Jun	44.34	40.60	40.56	49.71	66.51	94.98	119.90	144.71	195.42	154.99	195.89	235.92	254.47	247.32	267.91	131.14
Jul	44.78	41.00	40.97	50.20	67.16	95.92	113.88	144.96	205.00	161.16	196.19	234.67	283.47	267.91	240.37	126.89
Aug	45.66	41.80	41.77	51.19	68.48	97.80	114.78	141.04	180.56	147.81	187.78	231.90	254.75	240.37	261.65	126.58
Sep	46.54	42.61	42.57	52.17	69.80	99.68	122.08	147.43	189.34	169.56	203.52	236.88	226.45	261.65	260.40	119.67
Oct	47.42	43.41	43.38	53.16	71.11	101.56	123.20	161.94	179.96	180.24	212.08	232.95	233.11	260.40	244.26	121.42
Nov	48.30	44.22	44.18	54.14	72.43	103.44	126.46	163.40	149.38	182.14	214.02	234.69	263.77	244.26	270.27	117.83
Dec	42.15	38.59	38.56	47.25	63.21	90.27	121.07	149.72	139.67	163.92	211.73	227.77	267.66	270.27	220.41	113.43

B-11 Indicator of monthly trade value of finish products

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	61.85	58.96	62.08	70.39	84.70	92.50	100.00	111.07	119.57	75.14	93.80	114.27	99.66	91.26	75.84	66.88
Feb	63.22	60.27	63.46	71.96	86.58	94.55	99.71	109.17	119.11	73.27	93.64	111.25	114.19	104.56	86.90	76.64
Mar	64.59	61.58	64.84	73.52	88.46	96.61	119.20	125.85	129.82	83.35	110.90	136.93	112.12	102.66	85.32	75.24
Apr	67.34	64.20	67.59	76.65	92.22	100.72	108.20	119.18	136.04	80.01	105.94	128.52	110.04	100.76	83.74	73.85
May	68.03	64.86	68.28	77.43	93.17	101.75	117.86	124.46	133.16	80.57	105.59	133.12	107.97	98.86	82.16	72.46
Jun	69.41	66.17	69.66	79.00	95.05	103.80	119.90	127.21	136.71	87.85	111.03	133.72	105.89	96.96	80.58	71.06
Jul	70.09	66.82	70.35	79.78	95.99	104.83	113.88	127.44	143.42	91.35	111.20	133.01	104.85	96.01	79.79	70.37
Aug	71.47	68.13	71.73	81.34	97.87	106.89	114.78	123.98	126.31	83.78	106.43	131.44	102.77	94.11	78.21	68.97
Sep	72.84	69.45	73.11	82.91	99.75	108.94	122.08	129.60	132.46	96.11	115.35	134.27	101.74	93.16	77.42	68.28
Oct	74.22	70.76	74.49	84.47	101.64	111.00	123.20	142.36	125.90	102.16	120.21	132.04	97.58	89.35	74.26	65.49
Nov	75.59	72.07	75.87	86.04	103.52	113.05	126.46	143.64	104.50	103.24	121.31	133.02	95.51	87.45	72.68	64.10
Dec	65.97	62.89	66.22	75.09	90.34	98.66	121.07	131.62	97.71	92.91	120.01	129.10	93.43	85.55	71.10	62.70

B-12 Indicator of monthly transport volume of grain

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	86.35	88.39	99.32	84.72	86.59	100.28	100.00	93.66	118.50	97.94	113.17	103.64	147.58	128.46	151.92	134.58
Feb	83.20	89.79	93.81	77.89	82.76	88.49	83.89	92.30	110.22	99.06	98.29	108.66	148.74	119.38	149.35	136.12
Mar	96.82	97.63	106.22	88.17	95.39	101.76	101.74	93.16	110.44	129.94	118.31	135.19	131.81	132.74	149.65	160.88
Apr	88.14	94.01	102.84	88.09	88.27	93.97	96.04	99.21	109.20	124.87	118.77	135.88	127.59	128.58	147.97	171.59
May	93.55	94.62	96.02	94.77	92.17	93.27	111.39	98.85	110.08	112.01	128.51	136.94	118.01	145.88	149.15	153.91
Jun	83.91	81.22	86.11	86.76	83.84	84.63	89.44	93.02	92.13	109.68	119.32	114.36	124.21	135.45	124.84	150.71
Jul	81.24	82.03	81.78	88.41	92.84	84.42	92.29	93.59	112.91	104.21	120.25	105.61	114.71	136.51	152.99	143.19
Aug	90.28	91.67	87.35	94.92	95.93	86.88	106.11	118.42	114.65	103.97	113.24	110.48	120.00	128.55	155.36	142.86
Sep	94.74	83.17	78.47	97.04	97.61	85.62	98.54	119.35	112.98	108.87	125.16	107.21	123.96	126.46	153.09	149.60
Oct	83.44	83.37	81.41	95.55	86.80	100.00	100.35	112.80	108.33	91.02	109.19	99.76	108.35	123.95	146.79	125.07
Nov	81.89	86.78	81.70	89.74	94.05	85.83	93.96	108.74	91.98	89.82	104.83	109.95	119.42	119.00	124.64	141.09
Dec	83.62	83.97	84.12	102.77	96.80	95.02	98.19	102.55	86.32	114.74	106.47	115.88	118.35	136.47	125.62	157.67

B-13 Indicator of monthly transport volume of iron ore

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	64.52	58.33	64.14	72.76	74.02	86.98	100.00	119.08	120.44	91.78	142.03	125.02	178.96	170.36	169.13	162.58
Feb	60.43	61.49	53.74	67.64	84.27	79.34	89.56	94.72	117.35	116.15	121.46	112.75	189.22	165.98	170.58	176.71
Mar	61.56	63.76	66.13	69.40	87.18	101.98	103.16	116.05	114.16	122.20	137.30	139.44	167.65	161.48	185.21	185.91
Apr	62.79	65.02	73.06	70.23	87.20	94.98	96.27	112.15	128.73	135.06	124.73	133.54	168.73	182.08	168.26	205.48
May	69.48	65.68	66.87	76.18	69.47	89.68	92.90	101.02	120.91	128.94	128.55	144.26	164.37	171.02	173.41	196.15
Jun	60.53	55.86	59.31	71.13	75.79	87.73	102.44	95.50	120.73	131.91	136.26	140.56	156.34	170.77	183.81	200.68
Jul	65.11	68.09	71.01	72.15	87.15	86.74	92.52	111.48	124.76	142.14	133.83	148.24	150.28	176.47	191.76	216.25
Aug	68.95	64.33	70.05	67.69	76.79	96.66	112.75	105.06	117.39	128.19	143.72	167.93	148.23	166.05	193.87	195.01
Sep	58.55	62.78	72.04	77.15	89.75	91.56	90.15	109.76	122.56	159.52	143.38	159.99	147.06	173.35	193.40	219.73
Oct	59.24	64.39	72.12	69.45	78.88	90.55	95.32	108.57	108.69	124.16	154.52	157.63	140.84	153.73	208.44	188.89
Nov	62.57	64.19	70.25	71.11	86.33	105.81	101.99	117.17	105.79	108.87	135.77	158.97	133.71	149.64	183.15	165.62
Dec	62.25	65.57	67.69	81.15	98.28	99.68	120.48	114.31	110.71	119.57	163.36	179.42	118.91	156.60	220.36	181.90

B-14 Indicator of monthly transport volume of coal

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	63.03	76.18	74.36	79.56	77.00	88.29	100.00	93.63	94.05	93.92	113.72	162.25	162.25	144.14	143.85	145.42
Feb	60.85	64.46	67.35	72.78	73.13	80.48	81.93	89.12	83.17	87.20	100.83	164.79	164.79	127.80	127.22	120.94
Mar	66.53	65.57	75.85	77.21	82.61	82.96	91.80	97.19	101.02	96.05	106.15	162.42	162.42	134.54	154.51	142.92
Apr	61.23	73.79	69.49	76.73	86.78	92.16	90.05	101.89	104.17	91.58	119.53	163.73	163.73	151.50	159.33	143.45
May	64.00	74.76	71.22	75.19	87.21	90.75	97.92	97.43	104.20	88.87	123.49	141.87	141.87	156.52	159.38	134.26
Jun	64.29	71.52	73.68	73.93	84.00	87.45	90.97	94.28	102.07	116.59	122.40	154.51	154.51	155.15	156.12	152.74
Jul	67.89	72.68	66.42	74.83	80.07	86.32	92.10	98.39	96.48	111.03	120.30	144.79	144.79	152.48	147.57	143.78
Aug	70.36	72.21	75.47	76.62	87.68	83.48	90.45	99.57	105.10	101.94	123.33	133.67	133.67	156.32	160.76	163.02
Sep	67.52	68.91	70.05	76.79	79.29	86.96	94.82	100.87	110.96	116.71	125.93	127.45	127.45	159.61	169.72	154.47
Oct	67.33	69.26	71.65	82.39	86.69	92.16	92.56	98.05	111.80	117.65	128.80	121.36	121.36	163.26	171.00	156.58
Nov	63.61	64.33	66.88	78.41	79.61	76.60	93.69	101.95	107.96	104.04	120.89	123.69	123.69	153.23	165.12	155.60
Dec	65.78	68.54	76.77	80.96	86.81	89.94	100.96	111.66	100.96	118.41	128.77	130.71	130.71	163.22	154.42	157.99

B-15 Indicator of monthly transport volume of crude oil

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	92.44	99.81	93.35	95.10	100.05	101.95	100.00	97.10	101.57	86.45	101.95	105.75	90.45	78.94	88.88	81.56
Feb	92.49	99.05	95.72	95.29	99.90	101.19	100.57	101.24	98.62	93.20	102.57	110.08	81.84	79.80	85.50	85.93
Mar	92.02	94.87	92.02	96.53	98.38	102.47	102.19	95.01	99.76	88.55	102.33	112.26	100.38	84.93	92.63	80.09
Apr	94.20	98.34	93.20	96.20	99.76	100.00	98.15	100.33	99.19	87.64	102.57	109.36	88.02	82.84	85.98	77.66
May	95.10	98.10	93.44	97.58	98.62	102.99	97.10	96.58	98.00	88.40	102.57	108.46	87.31	94.34	79.61	81.94
Jun	91.16	93.58	94.44	99.48	99.57	99.10	98.05	99.76	93.58	84.65	101.14	111.12	87.17	84.51	82.32	82.08
Jul	94.91	93.16	94.72	98.95	105.47	104.52	104.09	101.52	101.14	88.02	102.52	115.45	97.10	91.54	85.22	79.42
Aug	98.57	99.33	94.87	98.19	101.09	103.23	101.62	94.63	99.52	100.19	101.90	116.16	87.26	82.13	80.80	79.23
Sep	96.06	96.63	95.25	97.72	103.94	103.47	101.05	92.54	100.71	99.90	102.28	115.73	77.57	89.40	77.04	74.90
Oct	97.53	98.43	90.02	99.62	98.91	97.81	101.57	96.25	90.40	101.14	102.76	114.73	79.85	88.97	86.50	76.00
Nov	96.39	96.44	96.82	98.91	104.13	98.15	101.09	92.54	97.86	101.38	100.76	116.35	90.35	83.46	85.98	78.52
Dec	96.67	97.15	101.76	99.71	100.43	102.99	101.19	102.33	95.63	101.52	105.04	86.60	91.68	92.35	79.42	75.76

B-16 Indicator of monthly transport volume of container

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	57.65	57.03	70.74	70.65	76.51	96.58	100.00	109.45	118.32	99.04	119.24	137.55	137.55	149.66	139.31	134.23
Feb	58.73	60.12	64.07	64.95	87.11	88.04	95.58	99.83	108.86	103.83	105.73	127.23	127.23	145.81	140.51	145.90
Mar	59.90	62.34	72.16	73.53	90.11	90.76	110.16	128.32	121.97	129.19	111.30	142.10	142.10	141.86	152.56	153.49
Apr	66.28	63.57	66.11	73.46	90.13	100.83	101.94	119.51	119.66	129.84	125.34	159.10	159.10	159.95	138.60	169.65
May	57.74	64.22	67.75	79.03	71.80	99.27	106.44	112.84	115.56	130.86	129.48	160.35	160.35	150.24	142.84	161.95
Jun	62.12	54.62	70.10	72.35	78.34	95.67	96.82	110.38	120.88	109.28	128.35	133.90	133.90	150.02	151.41	165.69
Jul	65.77	66.57	63.19	73.73	90.08	94.43	107.21	109.14	122.38	100.93	126.15	123.67	123.67	155.03	157.96	178.54
Aug	55.85	62.90	71.80	79.16	79.38	91.33	110.78	121.63	120.18	105.58	129.32	129.36	129.36	145.87	159.70	161.01
Sep	56.51	61.38	66.65	80.93	92.76	95.13	112.72	115.21	125.99	102.45	132.05	133.63	133.63	152.29	159.31	181.42
Oct	59.69	62.95	68.17	79.68	81.53	100.83	100.23	113.93	122.99	95.33	135.06	116.81	116.81	135.05	171.69	155.96
Nov	59.39	62.76	63.63	74.84	89.23	83.80	108.61	133.15	124.49	105.07	126.76	128.74	128.74	131.45	150.87	136.75
Dec	57.03	64.10	73.04	85.71	101.58	98.39	111.79	125.42	134.15	110.73	135.03	127.58	127.58	137.57	181.51	150.19

B-17 Indicator of monthly average of BCI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	57.65	69.75	35.30	76.41	255.33	203.42	100.00	209.18	324.87	59.66	135.78	55.58	62.03	48.42	72.95	21.07
Feb	61.93	63.11	39.47	76.72	243.51	212.30	122.48	212.34	326.98	106.81	113.13	46.20	49.33	46.97	56.25	20.56
Mar	74.62	61.67	45.22	85.30	209.38	202.37	123.68	243.16	378.06	82.05	120.66	56.52	48.72	42.84	92.94	14.75
Apr	77.56	58.61	44.79	91.45	178.91	213.26	112.41	281.00	405.41	74.12	110.41	54.03	51.04	41.56	63.40	17.07
May	71.60	60.21	39.15	99.20	144.36	170.22	103.99	308.86	564.76	125.15	155.44	53.83	51.61	45.26	59.57	26.28
Jun	69.08	58.85	39.23	97.16	131.42	103.41	113.86	255.91	531.40	242.79	127.45	63.03	39.88	55.00	59.41	35.05
Jul	72.04	49.28	37.93	95.85	171.66	98.88	133.98	283.57	444.24	189.11	66.16	65.22	44.22	66.73	48.75	54.84
Aug	74.85	37.19	38.67	107.60	199.94	100.93	172.52	327.14	391.95	147.85	100.33	69.02	38.78	69.52	62.30	63.51
Sep	78.17	34.63	49.06	119.23	186.99	134.39	179.65	398.36	226.49	108.60	121.26	105.10	45.09	116.49	77.48	51.98
Oct	82.45	34.06	59.68	207.21	201.34	157.74	181.81	499.15	83.66	139.86	139.88	113.94	70.70	110.68	70.06	50.94
Nov	84.62	32.47	63.41	209.37	249.50	146.69	192.65	509.76	34.56	222.36	122.84	102.99	76.61	83.80	105.81	29.67
Dec	76.48	32.99	74.51	220.76	257.03	117.27	197.29	491.72	39.39	177.95	91.09	118.14	53.22	129.13	32.63	24.13

B-18 Indicator of monthly average of BPI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	64.81	74.79	45.88	80.36	231.57	202.46	100.00	198.98	322.84	25.60	177.48	80.41	54.92	33.38	71.96	33.52
Feb	62.95	72.84	44.99	76.93	244.43	203.99	101.16	197.08	313.05	61.84	146.47	77.62	40.02	37.47	58.77	22.61
Mar	71.87	75.26	49.12	81.85	245.36	221.63	112.30	231.62	378.32	84.68	186.82	95.08	44.29	53.25	50.00	27.53
Apr	70.94	71.22	48.42	94.89	245.36	193.22	103.20	250.23	386.72	65.32	180.36	74.19	61.51	52.14	38.44	29.53
May	71.54	69.50	49.54	102.97	164.48	151.81	105.99	279.29	470.94	106.45	199.86	80.45	59.75	43.18	44.10	26.74
Jun	74.14	63.65	45.13	95.31	124.05	128.46	124.33	268.66	432.87	139.97	155.15	84.87	46.29	40.16	27.25	33.66
Jul	74.56	58.17	46.43	103.16	169.03	89.46	135.19	329.67	404.60	148.28	104.09	73.58	51.76	50.32	28.55	49.12
Aug	73.49	44.43	46.80	98.89	179.34	92.90	157.52	332.54	300.37	113.05	132.64	72.33	38.63	43.69	33.98	47.91
Sep	76.42	44.59	54.87	105.52	183.52	115.27	183.19	409.84	229.48	114.16	139.00	78.09	24.42	61.98	39.97	35.98
Oct	74.65	41.22	59.66	190.34	205.43	126.69	176.93	493.55	65.78	128.60	108.31	91.36	35.10	89.93	46.10	33.05
Nov	72.19	39.05	65.46	188.16	238.81	112.07	189.83	492.85	38.78	181.01	105.39	83.84	40.11	69.41	52.14	24.51
Dec	69.50	40.09	76.60	207.10	245.36	110.17	198.33	436.17	23.91	169.92	101.86	80.13	39.83	89.18	46.66	19.92

B-19 Indicator of monthly average of BDI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	60.60	69.24	41.18	74.89	231.21	199.04	100.00	197.27	317.00	39.99	140.08	61.94	45.94	34.09	65.08	32.05
Feb	61.59	65.40	42.42	74.00	240.96	200.39	108.04	194.44	303.93	80.28	118.40	52.22	31.08	32.94	50.40	23.83
Mar	71.66	66.39	47.08	81.78	226.87	206.83	114.90	226.51	356.47	86.56	141.78	66.01	37.98	38.73	65.61	25.47
Apr	73.71	63.67	47.64	91.24	198.46	200.40	109.01	254.39	366.39	73.36	134.55	59.38	45.14	38.64	46.20	26.13
May	70.85	64.03	45.67	98.65	158.98	162.15	107.96	283.06	479.43	112.29	169.69	59.78	48.68	37.63	43.82	26.40
Jun	70.24	60.90	43.99	94.44	128.29	121.41	120.19	255.21	452.97	169.01	136.53	63.36	41.43	41.60	40.32	30.91
Jul	71.55	54.00	43.71	96.91	167.06	98.16	134.84	290.58	395.08	148.64	84.44	60.40	46.69	49.65	35.19	43.11
Aug	72.48	43.33	44.29	101.07	184.33	97.39	163.00	318.12	327.29	118.70	107.54	61.32	33.65	48.10	41.43	47.13
Sep	75.67	41.81	52.28	108.89	183.08	123.94	178.58	379.61	219.97	104.24	120.24	81.35	31.26	74.32	49.65	39.31
Oct	76.68	39.71	60.37	184.04	200.70	139.78	178.08	460.96	79.92	121.40	119.08	91.61	42.09	83.25	48.68	35.06
Nov	76.16	37.81	64.57	187.92	234.72	128.90	185.26	466.13	36.21	174.23	102.63	81.13	45.32	68.93	58.89	25.73
Dec	71.16	38.47	73.66	203.78	244.01	114.95	191.70	435.68	32.85	157.95	89.80	82.63	37.85	96.30	40.23	22.95

B-20 Indicator of monthly average of BDTI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	58.88	105.53	47.57	90.79	125.55	90.37	100.00	73.38	82.95	42.65	66.89	42.42	48.19	39.16	66.84	54.01
Feb	67.91	87.58	42.45	103.62	99.23	88.71	82.17	69.40	64.82	35.05	56.07	44.03	47.42	39.93	48.25	51.52
Mar	76.41	99.70	41.22	117.71	84.55	91.68	68.27	68.81	78.73	37.75	57.54	59.66	48.90	38.92	41.47	48.25
Apr	76.17	79.92	44.05	78.25	68.63	72.31	60.67	69.99	91.44	28.53	56.97	50.98	46.29	36.48	40.34	46.58
May	84.85	65.95	46.87	72.73	74.51	80.69	70.05	71.12	115.21	28.39	62.24	46.70	44.80	35.12	39.33	49.14
Jun	95.37	55.02	44.59	52.38	86.39	72.79	74.39	61.44	115.45	36.42	54.14	44.21	40.29	36.90	39.87	57.10
Jul	104.52	58.12	44.14	52.38	88.41	69.46	84.85	62.03	123.11	30.69	48.99	43.97	38.03	37.85	49.32	50.03
Aug	110.16	59.60	39.44	46.58	80.81	62.21	86.33	50.93	89.72	28.83	45.92	41.53	36.66	35.00	45.63	39.28
Sep	103.09	60.55	39.99	60.13	83.30	75.76	75.94	50.44	89.01	30.42	40.94	40.70	37.85	35.65	37.97	39.10
Oct	123.77	59.18	54.96	64.65	159.12	117.35	76.89	56.09	81.82	33.58	43.43	47.53	39.75	38.21	41.59	45.16
Nov	128.22	46.13	70.77	86.81	181.22	130.60	65.24	65.95	63.28	37.99	48.63	46.23	41.53	48.43	52.70	51.22
Dec	134.46	48.24	80.21	112.18	140.46	125.37	71.60	114.91	76.05	44.77	60.61	50.33	43.79	66.84	50.56	54.49

B-21 Indicator of monthly average of CTRI

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	64.12	73.00	43.19	56.05	93.50	152.70	100.00	86.62	102.30	40.38	29.14	59.63	36.14	37.94	42.46	42.46
Feb	70.06	74.14	44.56	64.21	101.82	154.07	96.92	90.69	101.90	36.58	31.06	64.14	36.14	37.94	42.46	43.36
Mar	72.84	74.65	46.35	67.56	108.00	155.24	96.46	92.12	102.00	33.84	32.64	68.66	37.04	38.85	42.46	45.17
Apr	77.72	74.04	50.39	71.69	112.39	155.24	100.11	93.47	100.10	31.86	37.46	67.76	37.94	38.85	42.46	46.98
May	81.62	71.66	51.88	76.67	113.97	153.39	102.23	95.10	97.61	31.56	42.28	67.76	38.85	40.65	42.46	53.30
Jun	81.94	68.34	51.12	79.84	116.02	148.36	101.55	96.33	91.42	30.64	52.32	65.95	40.65	41.56	42.46	56.92
Jul	81.94	64.93	53.74	83.77	118.20	144.00	100.84	98.08	87.29	30.38	55.11	58.72	40.65	42.46	42.46	56.01
Aug	81.71	59.43	57.55	85.45	122.73	135.83	97.54	101.43	82.96	30.27	57.82	55.11	39.75	42.46	42.46	54.21
Sep	81.25	53.53	56.10	87.37	128.09	128.57	94.55	104.42	78.93	30.08	57.82	49.69	39.75	43.36	42.46	49.69
Oct	81.01	49.59	56.92	85.89	131.79	111.81	89.10	105.11	58.78	29.81	55.11	43.36	39.75	42.46	42.46	46.07
Nov	77.03	44.13	55.59	86.26	139.47	103.08	84.99	103.31	52.02	28.91	51.50	41.56	38.85	43.36	42.46	41.56
Dec	75.29	42.28	53.13	85.08	147.59	104.44	82.57	102.56	42.14	28.91	53.30	37.94	37.94	42.46	42.46	40.65

B-22 Indicator of monthly average price of 380cst Singapore

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	221.95	253.04	274.22	169.50	182.49	169.68	100.00	111.73	65.43	119.92	63.43	56.77	41.96	48.43	50.13	106.09
Feb	213.65	239.24	258.90	153.75	182.13	156.10	96.43	103.63	65.91	117.34	66.71	49.73	41.91	46.87	49.71	86.73
Mar	180.34	228.69	233.02	160.27	187.56	136.58	92.79	97.53	61.67	123.47	66.44	47.98	41.88	48.22	50.67	92.33
Apr	193.31	214.02	208.04	181.87	179.19	117.49	88.75	90.10	58.67	105.81	63.81	46.05	42.55	49.75	52.08	93.07
May	183.91	204.92	197.51	187.27	162.72	118.18	88.80	90.33	52.66	89.72	67.30	48.03	45.69	50.84	51.65	81.75
Jun	179.61	228.35	205.43	183.91	168.40	119.33	93.89	88.05	48.75	76.33	69.80	46.81	51.83	51.12	51.05	84.96
Jul	203.56	230.70	193.31	171.94	169.78	119.74	90.07	79.98	42.64	75.29	69.99	46.12	49.99	51.57	51.55	99.55
Aug	207.69	217.51	184.13	183.80	160.59	112.76	95.23	82.49	44.69	69.19	68.63	47.12	46.70	51.09	51.69	122.97
Sep	180.34	208.40	178.04	190.32	164.90	95.59	105.32	78.78	50.82	70.83	69.76	46.56	46.32	50.73	53.44	128.30
Oct	168.87	238.08	191.06	190.52	151.82	96.20	107.15	70.46	73.72	69.71	65.88	46.03	48.17	49.67	61.78	128.13
Nov	181.33	282.28	205.85	191.36	161.01	101.36	113.28	61.60	131.88	65.09	62.87	44.75	50.76	50.30	65.94	134.85
Dec	227.50	261.94	187.13	188.13	181.52	106.23	113.88	64.34	130.14	66.33	60.95	45.76	50.65	50.21	83.91	161.11

B-23 Indicator of monthly average price of 380cst Rotterdam

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	221.86	266.24	270.69	163.04	200.05	179.60	100.00	123.46	63.18	125.33	61.87	54.95	41.45	46.47	49.59	113.10
Feb	211.30	232.82	273.97	161.53	203.51	165.18	95.97	112.48	64.75	118.30	63.50	49.17	40.72	44.58	48.77	92.86
Mar	192.04	236.12	234.75	190.81	195.76	139.35	94.20	103.73	59.26	114.14	62.41	46.65	39.70	46.71	49.24	93.70
Apr	225.40	242.29	207.81	223.84	185.37	121.98	88.36	90.67	57.16	102.40	60.57	44.09	40.58	48.44	48.88	92.07
May	223.62	231.86	200.91	205.13	165.79	122.92	87.14	86.80	52.10	86.37	64.68	45.50	43.42	48.75	49.08	82.30
Jun	196.03	232.63	209.54	191.78	177.35	121.80	93.85	86.80	47.64	73.62	66.66	44.81	49.42	48.77	47.92	86.11
Jul	212.89	239.72	198.16	165.91	173.65	113.65	89.38	78.60	41.63	73.90	66.76	43.69	47.37	47.40	49.20	96.64
Aug	213.49	225.40	193.88	177.13	169.39	108.07	90.96	79.98	44.51	65.88	64.34	44.59	44.16	47.02	50.21	121.02
Sep	183.09	217.39	175.29	191.46	174.88	98.08	100.85	75.64	51.99	68.60	65.56	44.16	44.20	47.34	51.67	124.82
Oct	176.94	255.71	183.69	186.22	162.67	104.57	106.29	68.58	71.07	66.86	61.68	44.69	45.87	48.07	58.74	127.13
Nov	188.90	277.60	225.04	182.79	193.09	110.34	107.81	59.42	129.98	61.23	59.43	43.85	48.11	49.12	67.35	140.73
Dec	223.26	272.65	210.51	200.62	197.13	110.58	110.54	63.21	145.44	64.47	57.90	45.35	48.54	48.42	86.27	180.03

B-24 Indicator of monthly average price of MDO Singapore

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	251.65	217.05	333.07	209.41	180.97	143.34	100.00	107.09	66.59	110.04	84.00	65.42	54.01	55.87	56.54	93.62
Feb	228.76	251.50	328.38	182.13	186.17	138.29	104.48	101.06	64.40	139.26	85.54	59.59	52.45	53.67	56.95	89.69
Mar	212.04	262.89	298.63	186.01	186.58	113.67	99.21	97.62	55.82	135.14	81.02	54.21	51.74	56.97	57.20	84.22
Apr	245.47	235.96	259.26	226.29	182.48	108.02	85.37	89.38	50.41	119.39	75.50	52.12	52.67	58.99	57.14	88.50
May	239.04	231.28	249.88	246.36	166.34	117.52	82.84	87.83	44.01	111.65	80.06	54.81	55.38	59.52	57.53	87.62
Jun	224.07	239.51	248.23	243.20	172.13	108.11	82.22	86.66	42.48	91.82	82.71	55.46	62.41	59.11	62.43	91.90
Jul	220.82	241.80	253.32	242.77	160.80	102.74	81.47	84.25	41.39	99.06	82.22	54.51	59.34	57.97	57.95	100.69
Aug	191.26	242.49	250.24	228.96	141.41	100.00	81.40	85.03	50.74	87.83	80.80	56.93	54.93	57.63	59.22	118.11
Sep	166.19	239.45	248.82	222.10	140.94	91.15	81.40	78.29	57.10	92.72	82.26	56.70	53.97	57.87	61.22	120.76
Oct	174.27	269.92	232.04	222.08	126.51	93.96	99.06	74.15	77.31	92.63	76.26	57.63	54.87	58.66	65.56	121.92
Nov	193.01	309.37	231.99	210.74	131.66	105.40	99.53	66.47	100.86	83.70	73.35	54.16	56.44	57.95	71.13	135.88
Dec	231.69	331.75	222.69	201.92	143.44	108.92	99.38	73.47	117.25	87.21	68.49	55.90	56.74	56.30	80.41	152.89

B-25 Indicator of monthly average price of MDO Rotterdam

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	245.92	223.97	318.03	199.34	192.97	139.82	100.00	110.75	66.70	116.05	80.45	60.32	51.02	51.53	53.74	90.14
Feb	232.90	232.48	330.10	181.17	206.05	130.50	102.43	106.68	63.76	133.85	83.33	55.23	49.33	49.26	54.14	86.24
Mar	224.48	244.69	299.50	179.50	188.22	107.82	95.86	99.97	55.65	132.26	79.57	54.94	48.16	53.98	54.38	80.82
Apr	238.14	245.92	271.31	232.48	185.65	108.99	86.52	93.84	51.43	118.89	72.44	47.60	48.49	55.09	54.32	85.06
May	232.48	247.47	268.30	239.89	168.17	120.83	85.67	93.86	44.63	110.84	73.40	51.70	51.34	56.63	54.70	84.19
Jun	224.59	248.79	265.06	236.70	171.11	106.97	86.92	89.37	43.50	90.84	75.09	50.69	57.42	56.24	59.46	88.44
Jul	218.96	259.10	255.88	231.11	158.78	102.85	85.11	84.28	43.19	97.74	74.81	50.70	55.34	55.13	55.11	97.19
Aug	207.36	258.11	241.31	217.21	143.30	96.07	84.92	88.10	48.95	86.48	73.76	52.55	51.09	54.80	56.34	114.72
Sep	178.02	244.53	225.78	235.70	140.37	85.70	94.29	80.29	55.18	91.11	73.45	52.08	50.05	55.03	58.28	117.40
Oct	178.12	277.27	225.13	217.31	114.96	91.37	102.09	77.52	71.55	87.54	68.14	52.68	49.32	55.79	62.51	118.58
Nov	185.72	304.72	246.66	206.81	126.70	105.38	103.00	66.00	91.90	81.70	67.34	50.22	52.58	55.10	67.95	132.81
Dec	199.74	322.22	223.08	196.93	136.51	107.67	100.59	64.71	116.87	84.94	63.42	52.47	53.12	53.51	77.07	150.35

B-26 Indicator of monthly average brent price of crude oil

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	245.72	244.00	321.41	198.76	189.55	142.10	100.00	117.42	66.28	149.75	86.57	64.64	56.00	56.23	57.53	126.00
Feb	225.05	228.34	307.36	188.81	204.54	139.23	102.86	110.72	65.41	144.70	85.26	59.86	52.27	54.30	57.05	103.37
Mar	229.76	256.18	264.40	218.69	184.53	117.91	109.27	101.28	59.57	135.23	79.57	54.64	50.45	58.28	58.77	107.08
Apr	276.67	243.90	245.34	247.27	189.96	119.80	89.35	92.65	57.65	124.70	74.75	50.53	53.43	62.23	57.40	96.69
May	227.09	220.54	259.04	238.51	166.12	128.99	89.37	92.39	51.14	112.45	82.09	54.49	57.98	61.70	56.55	100.05
Jun	210.17	225.46	244.76	226.44	174.74	116.61	91.36	88.71	47.24	94.66	83.92	54.04	68.63	60.56	54.78	103.23
Jul	220.15	254.31	247.18	206.84	168.13	109.42	84.99	82.05	45.64	96.61	82.65	53.08	60.10	57.76	59.41	118.83
Aug	208.01	243.52	229.09	209.47	144.33	99.07	84.04	87.70	53.54	86.45	84.86	56.95	55.40	56.34	62.69	132.82
Sep	191.06	244.86	221.00	213.47	149.04	98.09	99.10	81.90	61.93	91.78	79.40	55.02	56.74	56.93	65.90	129.39
Oct	202.56	306.16	231.20	236.71	127.08	106.33	108.42	77.18	82.77	87.51	74.10	57.29	57.91	56.86	72.60	127.65
Nov	192.94	331.09	253.79	218.00	144.93	111.78	105.83	67.58	118.20	81.68	73.57	58.61	56.78	57.27	86.16	138.06
Dec	244.19	336.98	207.39	208.56	156.10	111.11	100.32	68.09	151.49	84.52	66.41	58.48	57.53	56.74	101.49	172.15

B-27 Indicator of monthly average WTI of crude oil

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	235.00	217.82	322.23	195.78	187.91	140.24	100.00	117.46	67.79	158.84	84.79	71.05	63.56	68.76	67.77	135.06
Feb	218.41	217.30	314.64	183.40	187.15	133.93	102.25	109.28	68.79	162.67	85.04	73.04	64.02	66.63	63.28	126.60
Mar	214.61	235.60	270.41	184.66	174.03	118.21	103.36	105.99	61.35	142.23	79.36	63.44	59.86	68.98	63.72	134.69
Apr	248.49	233.80	245.82	220.29	176.23	119.81	93.23	100.93	58.81	127.18	76.65	59.47	61.67	69.62	62.86	117.09
May	221.35	223.83	233.54	233.71	163.54	128.35	90.42	100.52	52.45	114.86	82.75	61.34	64.96	67.62	62.96	107.97
Jun	200.94	232.35	253.70	210.10	166.26	115.80	90.71	96.88	48.68	93.34	86.88	65.20	75.63	66.91	60.80	107.03
Jul	213.75	243.02	238.50	207.25	161.28	109.52	86.29	88.82	46.55	98.83	84.45	70.06	74.97	61.21	62.00	127.69
Aug	204.53	233.71	228.87	204.47	143.12	100.34	86.96	87.51	53.83	92.27	81.81	72.03	69.64	60.12	66.54	150.66
Sep	189.19	238.32	218.19	234.65	143.28	97.33	98.39	83.13	60.09	90.54	86.39	73.31	66.99	60.14	68.80	140.88
Oct	194.00	287.78	217.60	211.28	121.93	101.51	107.81	76.85	72.85	88.21	79.71	76.76	70.29	63.80	76.67	139.05
Nov	186.33	317.60	242.38	208.39	129.75	108.91	109.32	68.17	105.74	81.54	76.42	66.98	74.41	68.20	83.59	149.53
Dec	225.01	335.92	223.13	201.57	145.62	108.72	103.27	70.19	144.70	86.86	80.86	65.20	73.24	65.49	106.75	172.90

B-28 Monthly data of PIGMT with static weight

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	100.44	106.40	102.31	97.39	140.00	131.22	100.00	122.85	153.26	90.45	112.72	95.96	90.88	79.41	90.39	83.07
Feb	99.10	103.44	99.90	95.98	140.59	128.57	98.85	119.28	148.39	100.02	104.75	92.23	86.60	78.46	84.96	79.87
Mar	100.76	106.11	97.39	101.47	135.90	128.36	106.00	128.97	162.91	102.70	112.23	101.25	87.32	80.04	90.68	80.30
Apr	106.20	103.01	93.70	105.81	130.89	124.64	96.84	133.34	169.46	96.74	110.86	97.76	87.68	82.92	84.50	81.26
May	104.07	100.09	92.63	108.65	115.89	118.05	96.81	138.83	195.01	102.89	119.21	98.37	86.74	82.52	83.87	80.85
Jun	102.76	98.64	91.72	104.89	112.88	105.53	100.65	132.32	185.92	115.70	114.10	97.45	83.11	82.02	83.01	84.88
Jul	104.53	98.71	90.80	104.26	122.67	99.70	104.36	141.44	174.86	111.44	102.16	95.74	82.45	85.02	83.16	88.69
Aug	105.07	95.06	89.86	104.24	122.48	97.12	112.58	146.98	158.65	102.45	107.52	96.75	77.90	83.58	85.09	90.46
Sep	100.29	93.03	89.81	109.76	124.00	102.18	114.78	162.29	134.34	101.30	111.12	99.78	75.73	91.07	87.25	89.29
Oct	101.82	97.69	93.26	126.74	129.88	108.86	114.63	181.65	101.14	103.22	109.57	100.06	77.45	91.17	89.38	85.16
Nov	102.23	100.33	98.33	127.32	143.03	106.88	118.39	183.71	95.37	114.04	104.08	97.96	80.32	86.10	91.59	82.92
Dec	107.23	100.84	98.71	133.77	144.66	104.56	120.35	179.87	96.97	112.13	104.01	99.86	77.49	98.76	88.62	88.14

B-29 Static weights of indicators

A	weight	B	weight	C	weight	D	weight	f-weight
Quantity	0.5	Supply	0.5	Order	0.3	Dry Bulk	0.5	0.0375
						Tanker	0.3	0.0225
						Container	0.2	0.015
				Capasity	0.7	Dry Bulk	0.4	0.07
						Tanker	0.3	0.0525
						Container	0.3	0.0525
		Demand	0.5	Trade Value	0.3	Grain	0.1	0.0075
						Crude Oil	0.3	0.0225
						Iron ore	0.2	0.015
						Coal	0.1	0.0075
						Products	0.3	0.0225
				Trade Volume	0.7	Grain	0.13	0.02275
						Crude Oil	0.25	0.04375
						Iron ore	0.22	0.0385
						Coal	0.17	0.02975
						Container	0.23	0.04025
Profit	0.5	Price	0.7	Spot Freight	1	BPI	0.2	0.07
						BCI	0.2	0.07
						BDI	0.2	0.07
						CTRI	0.2	0.07
						BDTI	0.2	0.07
		Cost	0.3	Spot Price	0.7	380 Singapore	0.3	0.0315
						380 Rotterdam	0.3	0.0315
						MDO Singapore	0.2	0.021
						MDO Rotterdam	0.2	0.021
				Future Price	0.3	Brent	0.5	0.0225
						WTI	0.5	0.0225

B-30 Dynamic weights of indicators

A	weight				B	weight				C	weight				D	weight				f-weight			
	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4	1	2	3	4
Quantity	0.5	0.5	0.45	0.45	Supply	0.55	0.5	0.45	0.45	Order	0.35	0.3	0.28	0.25	Dry Bulk	0.45	0.5	0.5	0.45	0.04331	0.0375	0.02835	0.02278
															Tanker	0.35	0.3	0.25	0.25	0.03369	0.0225	0.01418	0.01266
															Container	0.2	0.2	0.25	0.3	0.01925	0.015	0.01418	0.01519
										Capasity	0.65	0.7	0.72	0.75	Dry Bulk	0.45	0.4	0.35	0.3	0.08044	0.07	0.05103	0.04556
															Tanker	0.35	0.3	0.35	0.35	0.06256	0.0525	0.05103	0.05316
															Container	0.2	0.3	0.3	0.35	0.03575	0.0525	0.04374	0.05316
					Demand	0.45	0.5	0.55	0.55	Trade Value	0.35	0.3	0.28	0.25	Grain	0.1	0.1	0.1	0.1	0.00788	0.0075	0.00693	0.00619
															Crude Oil	0.25	0.3	0.35	0.3	0.01969	0.0225	0.02426	0.01856
															Iron ore	0.25	0.2	0.2	0.2	0.01969	0.015	0.01386	0.01238
															Coal	0.1	0.1	0.1	0.1	0.00788	0.0075	0.00693	0.00619
															Products	0.3	0.3	0.25	0.3	0.02363	0.0225	0.01733	0.01856
										Transport Volume	0.65	0.7	0.72	0.75	Grain	0.1	0.13	0.15	0.15	0.01463	0.02275	0.02673	0.02784
															Crude Oil	0.25	0.25	0.22	0.2	0.03656	0.04375	0.0392	0.03713
															Iron ore	0.2	0.22	0.23	0.2	0.02925	0.0385	0.04099	0.03713
															Coal	0.2	0.17	0.15	0.18	0.02925	0.02975	0.02673	0.03341
															Container	0.25	0.23	0.25	0.27	0.03656	0.04025	0.04455	0.05012
Profit	0.5	0.5	0.55	0.55	Price	0.65	0.7	0.65	0.75	Spot Freight	1	1	1	1	BPI	0.17	0.2	0.15	0.15	0.05525	0.07	0.05363	0.06188
															BCI	0.18	0.2	0.15	0.15	0.0585	0.07	0.05363	0.06188
															BDI	0.19	0.2	0.2	0.2	0.06175	0.07	0.0715	0.0825
															CTRI	0.22	0.2	0.25	0.27	0.0715	0.07	0.08938	0.11138
															BDTI	0.24	0.2	0.25	0.23	0.078	0.07	0.08938	0.09488
					Cost	0.35	0.3	0.35	0.25	Spot Price	0.65	0.7	0.75	0.75	380 Singapore	0.28	0.3	0.27	0.26	0.03185	0.0315	0.03898	0.02681
															380 Rotterdam	0.25	0.3	0.23	0.24	0.02844	0.0315	0.03321	0.02475
															MDO Singapore	0.25	0.2	0.26	0.25	0.02844	0.021	0.03754	0.02578
															MDO Rotterdam	0.22	0.2	0.24	0.25	0.02503	0.021	0.03465	0.02578
										Future Price	0.35	0.3	0.25	0.25	Brent	0.6	0.5	0.55	0.5	0.03675	0.0225	0.02647	0.01719
															WTI	0.4	0.5	0.45	0.5	0.0245	0.0225	0.02166	0.01719

B-31 Monthly data of PIGMT with dynamic weight

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Jan	103.16	108.86	107.94	99.69	137.20	131.22	100.00	122.85	153.26	90.45	106.87	92.19	88.06	78.33	88.66	79.26
Feb	101.48	106.17	105.08	98.23	137.50	128.57	98.85	119.28	148.39	100.02	99.35	88.65	84.26	77.12	83.42	76.31
Mar	102.73	109.52	101.48	103.82	132.45	128.36	106.00	128.97	162.91	102.70	106.21	97.59	85.03	79.02	88.44	77.52
Apr	109.51	105.90	97.27	108.20	128.18	124.64	96.84	133.34	169.46	96.74	104.68	94.19	85.35	81.82	83.15	79.06
May	106.14	102.31	96.57	110.93	114.51	118.05	96.81	138.83	195.01	102.89	112.71	94.93	84.55	81.80	82.48	78.56
Jun	105.55	101.60	95.47	107.31	113.09	105.53	100.65	132.32	185.92	115.70	108.35	93.60	81.79	81.04	81.99	82.65
Jul	106.74	101.95	94.65	106.38	121.17	99.70	104.36	141.44	174.86	111.44	98.07	91.78	80.92	83.89	82.47	86.51
Aug	106.89	98.75	93.11	105.50	119.33	97.12	112.58	146.98	158.65	102.45	102.60	92.98	76.59	81.97	84.29	87.69
Sep	101.47	96.86	92.79	111.05	121.02	102.18	114.78	162.29	134.34	101.30	105.69	95.28	74.69	88.63	85.88	86.61
Oct	103.60	102.52	96.23	125.51	126.77	108.86	114.63	181.65	101.14	103.22	104.28	95.36	75.82	88.26	88.40	82.53
Nov	103.78	105.80	101.53	125.94	138.87	106.88	118.39	183.71	95.37	114.04	99.18	93.58	78.67	83.87	90.51	80.21
Dec	110.31	106.65	100.98	132.00	140.05	104.56	120.35	179.87	96.97	112.13	99.77	95.38	76.17	94.60	89.15	85.05

B-32 The $SCFI_e$, the DCFI and the $DCFI_d$ in risk analysis

Date	$SCFI_e$	DCFI	$DCFI_d$	Date	$SCFI_e$	DCFI	$DCFI_d$
10/17	1000.00	1000.00	1000.00	11/11	1103.60	1170.90	1078.67
10/18	1000.00	978.60	970.55	11/12	1103.60	1190.30	1105.93
10/19	1000.00	1011.70	992.56	11/13	1103.60	1226.12	1148.46
10/20	1000.00	939.79	935.30	11/14	1091.41	1102.88	1012.74
10/21	1000.00	966.67	914.83	11/15	1091.41	1078.09	1010.74
10/22	1000.00	963.00	936.99	11/16	1091.41	1110.89	1051.88
10/23	1000.00	984.54	993.51	11/17	1091.41	1064.14	995.54
10/24	1004.77	973.62	965.62	11/18	1091.41	1069.31	1011.50
10/25	1004.77	927.63	876.35	11/19	1091.41	1106.44	1025.65
10/26	1004.77	972.28	941.05	11/20	1091.41	1208.02	1146.39
10/27	1004.77	925.86	873.61	11/21	1051.88	1097.68	1043.31
10/28	1004.77	911.07	835.91	11/22	1051.88	1099.44	1054.03
10/29	1004.77	897.34	846.67	11/23	1051.88	1060.58	1008.15
10/30	1004.77	1056.03	1010.00	11/24	1051.88	1016.04	978.24
10/31	1155.06	969.83	906.77	11/25	1051.88	949.49	905.12
11/01	1155.06	1163.50	1074.64	11/26	1051.88	1024.89	970.12
11/02	1155.06	1292.66	1222.36	11/27	1051.88	1140.13	1080.08
11/03	1155.06	1150.20	1067.32	11/28	986.42	1022.15	980.00
11/04	1155.06	1150.43	1067.71	11/29	986.42	1032.74	997.90
11/05	1155.06	1232.47	1139.86	11/30	986.42	1014.64	967.88
11/06	1155.06	1292.47	1187.73	12/01	986.42	904.33	838.24
11/07	1103.60	1189.44	1114.54	12/02	986.42	963.02	915.06
11/08	1103.60	1226.93	1104.98	12/03	986.42	921.47	854.25
11/09	1103.60	1284.25	1179.59	12/04	986.42	917.67	840.80
11/10	1103.60	1181.19	1091.50	12/05	954.59	917.71	876.06

C. Questionnaire for the indicators of the PIGMT

Round 1 of Questionnaire

Respected Savant:

We are designing a new index named the prosperity index of global maritime transport market (PIGMT). According to the rationale of the prosperity index, we draft the framework of the PIGMT as follow:

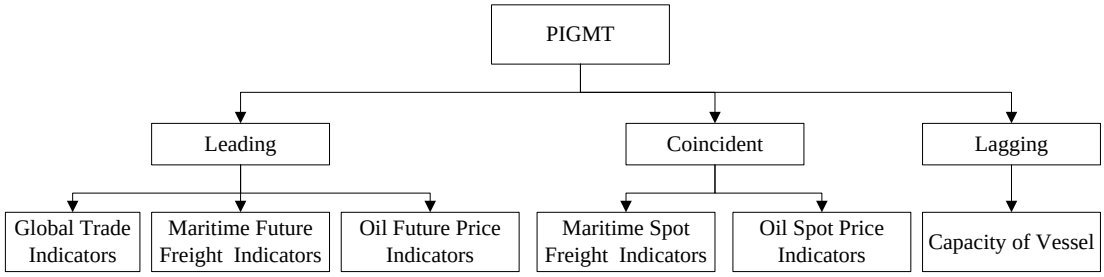


Fig. C-1 The framework of the PIGMT

We think the PIGMT is a composite index that includes three parts indicators: leading index, coincident index and lagging index.

Leading indicators are indicators that usually change before the economy as a whole change. They are therefore useful as short-term predictors of the economy. For the global maritime transport market, various global trade indicators, Freight Forward Agreement index and fuel future price are in the leading group.

Coincident indicators change at approximately the same time as the whole economy, thereby providing information about the current state of the economy. A coincident index may be used to identify, after the fact, the dates of peaks and troughs in the business cycle. Coincident indicators of the PIGMT are mainly from global maritime transport market. As fuel price is the important factor for cost of maritime transport industry, some indicators of global fuel market should be considered.

Lagging indicators are indicators that usually change after the economy as a whole does. Typically the lag is a few quarters of a year. From the side of supply chain, new building and demolition of vessels is guide by maritime transport industry. Therefore some indicators of ship market will be considered in lagging group.

In this framework, there are many candidate indicators published by different organizations. To make the calculation simple and the selected indicator credible, it is necessary to choose some representative one from them.

The principles of the indicators selection for the PIGMT are as follow:

Principle A: global indicator

Principle B: quantitative indicator

Principle C: recognized indicator, at least in maritime transport market

Principle D: no or very weak correlation between indicators

Principle E: for every sub-market, no more than 3 indicators.

Now we edit 6 tables including 117 indicators chosen for the PIGMT in next pages. As a

famous expert in maritime transport industry, you are invited to support us make selection from the indicator listed in next table. Your kindly support will enhance our research reliability.

Please give us your opinion about how important is for each indicator in every group according to this rule: for score1, please give 1~5 point, 1 means very weak, 5 means very strong; for score 2, please give 1~9 point, 1 means very weak, 9 means very strong.

Tab C-1, tab C-2, tab C-3, tab C-4, tab C-5 and tab C-6 are listed as follows.

Thank you very much for your help! When all of feedback is received, we will share the result with you.

Zhao Yifei
Candidate of PHD degree of the University of Tokyo
Mar. 23, 2014

Tab C-1 Indicators for global trade

Item	Score1	No.	Indicators	Data Source	Score2
Trade Volume		1	Volume growth rates of merchandise exports and imports	UNCTAD	
		2	Values and shares of merchandise exports and imports		
		3	Value growth rates of merchandise exports and imports		
		4	Merchandise trade balance		
		5	Value, volume and unit value indices of merchandise exports and imports		
		6	Values and growth of exports and imports of total services		
		7	Values, shares and growth of exports and imports of total services		
		8	Exports and imports of goods and services		
Trade Structure		9	Intra-trade of regional and trade groups by product		
		10	Merchandise trade matrix - product groups, exports in thousands of dollars		
		11	Merchandise trade matrix - detailed products, exports in thousands of dollars		
		12	Merchandise trade matrix - product groups, imports in thousands of dollars		
		13	Merchandise trade matrix - detailed products, imports in thousands of dollars		
		14	Value, shares and growth of services exports and imports by service-category		
Trade indicator		15	Terms of trade indices and purchasing power indices of exports		
		16	Bilateral concentration indices of merchandise exports and imports		
		17	Comparative diversification indices of merchandise exports and imports		
		18	Concentration and structural change indices of merchandise exports and imports by product		
		19	Merchandise trade complementarity		
		20	Merchandise trade specialization index		
		21	Merchandise trade correlation index		
		22	Goods and services trade balance indicators		
		23	Goods and services trade openness		

Tab C-2 Indicators for global maritime transport future freight

Item	Score1	No.	Indicators		Data Source	Score2
Future Freight Indicators		1	Dry Bulk	Dry FFA	BE	
		2	Tanker	Wet FFA		
		3	Container Liner	SCFI FFA	SSE	

Tab C-3 Indicators for global petroleum future price

Item	Score1	No.	Indicators	Data Source	Score2
Future Price of Crude Oil		13	Brent Crude	ICE	
		14	WTI Crude		
		15	Gasoil		
		16	Low Sulphur Gasoil		
		17	RBOB		
		18	180 Cst Singapore		
		19	Dubai 1st Line		
		20	Brent 1st Line		
		21	Arab Light Crude Oil Price		
		22	Crude Oil Futures	NYME	
		23	Natural Gas (Henry Hub) Physical Futures		
		24	NY Harbor ULSD Futures		
		25	Natural Gas European Options		
		26	RBOB Gasoline Physical Futures		
		27	Henry Hub Penultimate NP Futures		
		28	Henry Hub Swap Futures		
		29	Brent Crude Oil Financial Futures		
		30	Crude Oil Options		

Tab C-4 Indicators for global maritime spot freight

Item	Score1	No.	Indicators		Data Source	Score2
Freight Indicator		1	Dry Bulk	Baltic Dry Index	BE	
		2		Baltic Capsize Index		
		3		Baltic Panamax Index		
		4		Baltic Handymax Index		
		5		Baltic Handysize Index		
		6		Baltic Supramax Index		
		7		Baltic Freight Index		
		8		Atlantic Capesize Index	SSY	
		9		Pacific Capesize Index		
		10		Clarkson Average Bulk Earning	CSRL	
		11		ICAP Supramax Index	ICAP	
		12		ICAP Handymax Index		
		13		China Import Dry Bulk Freight Index	SSE	
		14		China Coastal Bulk Freight Index		
		15		China Coastal Bulk (Coal) Freight Index		
		16	Tanker	Baltic Dirty Tanker Index	BE	
		17		Baltic Clean Tanker Index		
		18		Crude Freight Rates	SSY	
		19		Product Freight Rates		
		20		Crude Tanker Spot Earnings	CSRL	
		21		Product Tanker Spot Earnings		
		22		New Worldwide Tanker Nominal Freight Scale	WS	
		23		China Import Crude Oil Tanker Freight Index	SSE	
		24	Container liner	Container Vessel Time Charter Rate Index	CRSL	
		25		China Export Container Freight Index	SSE	
		26		Shanghai Container Freight Index		

Tab C-5 Indicators for global petroleum spot price

Item	Score1	No.	Indicators		Data Source	Score2
Spot Price of Crude Oil		1	Cushing, OK WTI Spot Price FOB		EIA	
		2	Europe Brent Spot Price FOB			
		3	Arab Light Crude Oil Price FOB			
		4	New York Harbor Conventional Gasoline Regular Spot Price FOB			
		5	U.S. Gulf Coast Conventional Gasoline Regular Spot Price FOB			
		6	Los Angeles Reformulated RBOB Regular Gasoline Spot Price			
		7	New York Harbor No. 2 Heating Oil Spot Price FOB			
		8	New York Harbor Ultra-Low Sulfur No 2 Diesel Spot Price			
		9	U.S. Gulf Coast Ultra-Low Sulfur No 2 Diesel Spot Price			
		10	Los Angeles, CA Ultra-Low Sulfur CARB Diesel Spot Price			
		11	U.S. Gulf Coast Kerosene-Type Jet Fuel Spot Price FOB			
		12	Mont Belvieu, TX Propane Spot Price FOB			
Bunker price		13	380	Antwerp	http://navigatemag.ru/bunker/	
		14		Hamburg		
		15		Rotterdam		
		16		Istanbul		
		17		Venice		
		18		Houston		
		19		Los Angeles		
		20		New York		
		21		Busan		
		22		Hong Kong		
		23		Kaohsiung		
		24		Shanghai		
		25		Singapore		
		26		Tokyo		
		27		Kuwait		
		28	MOD	Antwerp		
		29		Hamburg		
		30		Rotterdam		
		31		Istanbul		
		32		Venice		
		33		Houston		
		34		Los Angeles		
		35		New York		
		36		Busan		
		37		Hong Kong		
		38		Kaohsiung		
		39		Shanghai		
		40		Singapore		
		41		Tokyo		
		42		Kuwait		

Tab. C-6 Indicators for global fleet capacity

Item	Score1	No.	Indicators		Data Source	Score2
Fleet Capacity		1	New building order capacity	Bulk Carrier	CSRL	
		2		Tanker		
		3		Container Vessel		
		4	Present capacity	Bulk Carrier		
		5		Tanker		
		6		Container Vessel		

Round 2 of Questionnaire

Respected Savant:

Thank you very much. Under the support of you and other 19 experts, the second version of indicator system of the PIGMT was born as table C-7.

The key points of second version are as follow:

1. Some indicators are different with first version because most of you recognize the trade value and volume of goods should be change to special goods. Fortunately, the database of UNCTAD gives the data of the value and volume of coal, grain, iron ore, crude oil and products. So we add them instead of the total value and volume.
2. We are going to reduce the number of each kind of bunker price to two, please give us your opinion which is better.
3. If the crude oil spot price is necessary? Compared with bunker price, which one is more important?
4. We wish the number of indicators is less than 30 if possible.

Please give us your opinion about how important is for each indicator in every group according to this rule: for score1, please give 1~5 point, 1 means very weak, 5 means very strong; for score 2, please give 1~9 point, 1 means very weak, 9 means very strong.

Thank you again for your help! When all of feedback is received, we will share the result with you.

Zhao Yifei
Candidate of PHD degree of the University of Tokyo
May 15, 2014

Tab. C-7 The candidate indicators for second round

Item	Score1	No.	Indicators		Data Source	Score2
Trade		1	Value	Grain	UNCTAD	
		2		Coal		
		3		Iron Ore		
		4		Crude Oil		
		5		Products		
		6	Volume	Grain		
		7		Coal		
		8		Iron Ore		
		9		Crude Oil		
		10		Container		
Freight indicator		11	Dry Bulk	BDI	BE	
		12		BCI		
		13		BPI		
		14	Tanker	BDTI		
		15		BCTI		
		16	Container	SCFI	SSE	
		17		CTRI	CSRL	
Spot Price of Crude Oil		18	Cushing, OK WTI Spot Price FOB		EIA	
		19	Europe Brent Spot Price FOB			
		20	Arab Light Crude Oil Price FOB			
Bunker price		21	380	Singapore	http://navigatemag.ru/bunker/	
		22		Rotterdam		
		23		New York		
		24		Hong Kong		
		25		Kuwait		
		26	MOD	Singapore		
		27		Rotterdam		
		28		New York		
		29		Hong Kong		
		30		Kuwait		
Fleet Capacity		34	New building order capacity	Bulk Carrier	CSRL	
		35		Tanker		
		36		Container Vessel		
		37	Present capacity	Bulk Carrier		
		38		Tanker		
		39		Container Vessel		
Future Freight Indicators		40	Dry Bulk	Dry FFA	BE	
		41	Tanker	Wet FFA		
		42	Container Liner	SCFI FFA	SSE	
Future Price of Crude Oil		43	Brent Crude		ICE	
		44	WTI Crude			
		45	Arab Light Crude Oil Price			
		46	Crude Oil Futures		NYME	
		47	Brent Crude Oil Financial Futures			
		48	Crude Oil Options			

Round 3 of Questionnaire

Respected Savant:

Thank you very much. Under the support of you and other 19 experts, the second version of indicator system of the PIGMT was born as Fig. C-2.

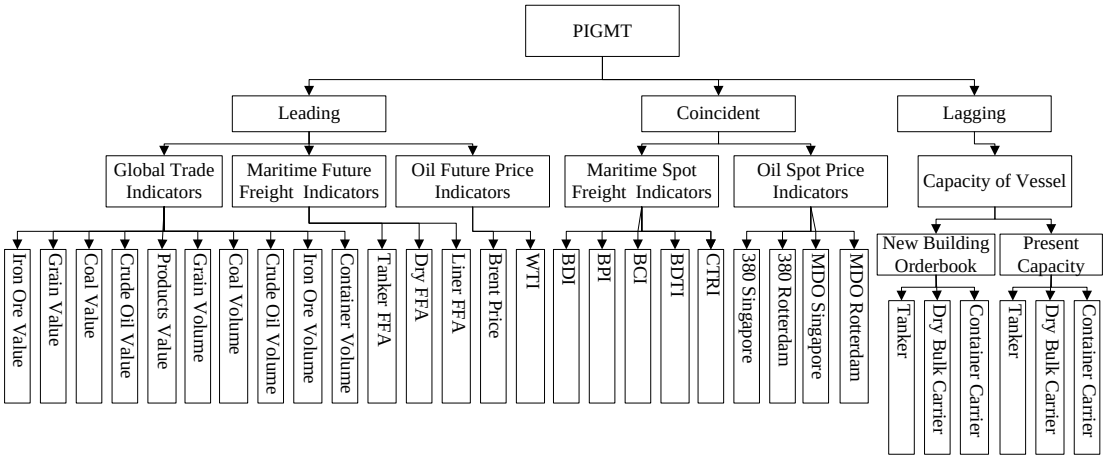


Fig. C-2 The indicator system of the PIGMT

If you think this indicator system of the PIGMT has some mistake, please let us know directly.

If the number of comments is over 5 items, we will give you our modified version.

Thank you again for your help!

Zhao Yifei
Candidate of PHD degree of the University of Tokyo
August 30, 2014

D. Questionnaire for the weight of the PIGMT indicators

Respected Savant:

Thank you very much for your support. According to 20 savants' opinion (include yours), the indicators of the PIGMT are selected as the fig. D1.

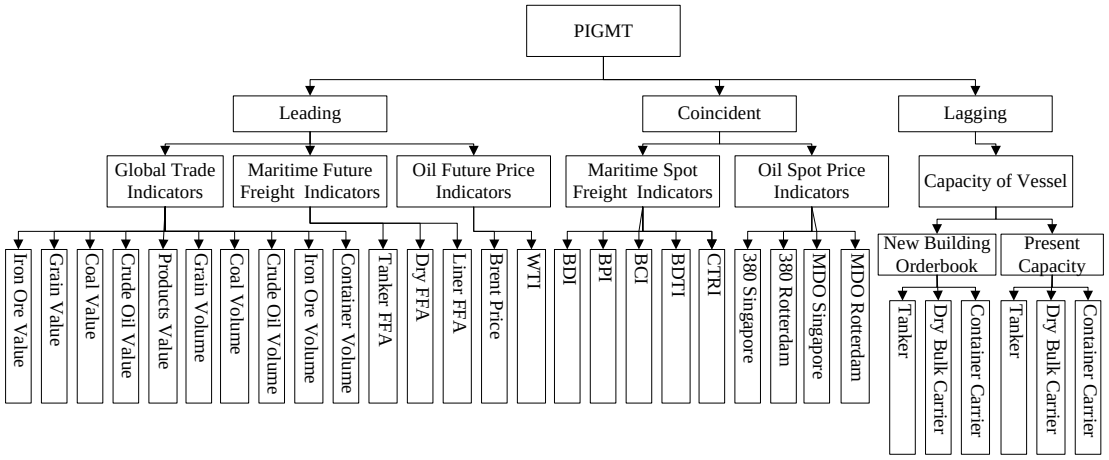


Fig. D1 The indicator theoretical structure of the PIGMT

The indicators of theoretical framework of the PIGMT are difficult to be compared. If the theoretical structure is changed to market structure (see fig. D2), the relationship of these indicators can be understood easily.

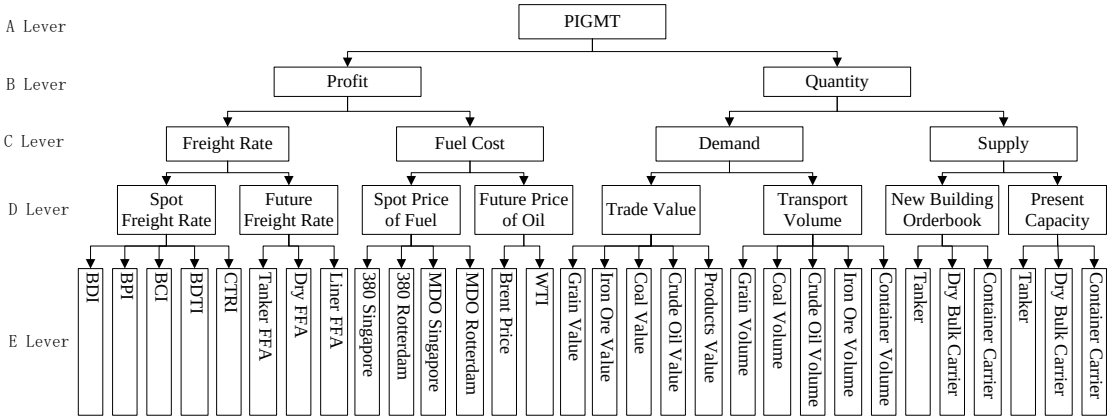


Fig. D2 The indicator market structure of the PIGMT

The indicator system in fig. D2 has five hierarchies. From this structure, the prosperity of maritime transport market can be understood like as follows. The situation of the market can be showed by two parts: profitability and market quantity. If profitability is on the rise path, or the market quantity is growth up, the market is flourishing. Both of profitability and scale is in the down channel, the market is in depression.

Profitability depends on two factors: income and cost. In the global maritime transport market, profit is positively related to income and freight rates, negatively related to cost, and cost

is positively related to fuel price. For market quantity, demand is greater than or equal to supply, market boom; supply is greater than demand, the market downturn.

Freight rate includes spot freight and future freight. BDI, BCI, BDTI, etc. give the spot freight for dry bulk market or tanker market. Tanker FFA, dry bulk FFA and Container liner FFA are the examples of the future freight. In petroleum market, there are also spot price and future price for different petroleum products. For maritime transport market, direct spot prices of fuel are the prices of 380 and MDO, future prices of fuel are WTI and Brent price. The indicators of trade value are divided into five parts according the goods kinds that are coal, iron ore, grain, products and crude oil. Corresponding to the five kinds of goods, the transport volume also are divided into five parts. These five parts goods need three kinds of vessel to transport: dry bulk carrier, tanker and container vessel. Therefore, the global capacity of these three kinds vessel is the important indicators of supply. Present capacity means existed capacity. The volume of new building order book means future added capacity.

After the work above, we need to know the weight of every indicator. Table D1 gives the indicators that need your weighting. Specially, there is no future freight indicator in this tab because the data of FFA is not enough. Therefore, there are 27 indicators in table D1.

Tab. D1 Weight evaluation for indicators of the PIGMT

A	weight A	B	weight B	C	weight C	D	weight D
Quantity	W_{a1}	Supply	W_{b1}	New Building Order	W_{c1}	Dry Bulk	W_{d1}
						Tanker	W_{d2}
						Container	W_{d3}
				Present Capasity	W_{c2}	Dry Bulk	W_{d4}
						Tanker	W_{d5}
						Container	W_{d6}
		Demand	W_{b2}	Trade Value	W_{c3}	Grain	W_{d7}
						Crude Oil	W_{d8}
						Iron ore	W_{d9}
						Coal	W_{d10}
						Products	W_{d11}
				Trade Volume	W_{c4}	Grain	W_{d12}
						Crude Oil	W_{d13}
						Iron ore	W_{d14}
						Coal	W_{d15}
						Container	W_{d16}
Profit	W_{a2}	Freight	W_{b3}	Spot Freight	1	BPI	W_{d17}
						BCI	W_{d18}
						BDI	W_{d19}
						CTRI	W_{d20}
						BDTI	W_{d21}
		Cost	W_{b4}	Fuel Spot Price	W_{c5}	380 Singapore	W_{d22}
						380 Rotterdam	W_{d23}
						MDO Singapore	W_{d24}
						MDO Rotterdam	W_{d25}
				Future Price	W_{c6}	Brent	W_{d26}
						WTI	W_{d27}

For the test calculation of the PIGMT, the collected data is start from Jan. 2000. During Jan. 2000 to Dec. 2015, we divided them in four cycles: ①Jan. 2000-Dec.2004, ②Jan. 2005-Dec. 2009, ③Jan. 2010-Dec. 2014 and ④Jan. 2015- Dec.2019. So, the dynamic weight for the different cycle can be set like as table B-30. Please give your opinion about the weight (wa1, wa2, ……, wd27) for each indicator in every cycle in table D2. Meanwhile, lease note carefully:

$w_{a1}+w_{a2}=1$

$w_{b1}+w_{b2}=1$, $w_{b3}+w_{b4}=1$

$w_{c1}+w_{c2}=1$, $w_{c3}+w_{c4}=1$, $w_{c5}+w_{c6}=1$

$w_{d1}+w_{d2}+w_{d3}=1$, $w_{d4}+w_{d5}+w_{d6}=1$, $w_{d7}+w_{d8}+w_{d9}+w_{d10}+w_{d11}=1$,

$w_{d12}+w_{d13}+w_{d14}+w_{d15}+w_{d16}=1$, $w_{d17}+w_{d18}+w_{d19}+w_{d20}+w_{d21}=1$,

$w_{d22}+w_{d23}+w_{d24}+w_{d25}=1$, $w_{d26}+w_{d27}=1$.

Thank you very much for your help! When all of feedback is received, we will share the result with you.

Zhao Yifei
Candidate of PHD degree of the University of Tokyo
Feb 20, 2016

Tab.D2 Weight assignment

Year	2000-2004	2005-2009	2010-2014	2015-2019
W_{a1}				
W_{a2}				
W_{b1}				
W_{b2}				
W_{b3}				
W_{b4}				
W_{c1}				
W_{c2}				
W_{c3}				
W_{c4}				
W_{c5}				
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W_{d27}				

Publications During Research

1. Books

[1]Tatsuo Yanagita, Yi Wan, Yifei Zhao, *East Asia Under the Relative Leadership*. Shanghai Jiao Tong University Press, ISBN 978-7-313-13544-5, Dec. 2015

[2]ZHAO Yifei, CHEN Guoqing. *The practices and regulations of intermodal transport (Second Version)*, East China Normal University Press, ISBN 978-7-5675-1657-1, July 2015

[3]CHEN Guoqing, ZHAO Yifei, *Study on Co-opetition of Port Supply Chain*, Shanghai Jiao Tong University Press, ISBN 978-7-313-08098-1，April 2012，

2. Papers

[1] ZHAO Yifei, ZHANG Dali, Tatsuo Yanagita. *Container liner freight index based on data from e-booking platform*. Presentation in the World Conference of Transport Research, Shanghai, July 2016

[2]YANG Dongming，ZHAO Yifei，Tatsuo Yanagita. *A frame study of correlation analysis between open macroeconomic system and container throughput*. Presentation in the World Conference of Transport Research, Shanghai, July 2016

[3] YANG Dongming，ZHAO Yifei. Case study on macro economy and container throughtput for hub port. Journal of Japan Logistics Society, No.24, May 2016, 49-56

[4]FU Dongfang, ZHAO Yifei. *Research on data source and algorithm of containerized freight index*. Journal of Dalian Maritime University, Vol.41, No.3, August 2015, 87-92

[5]Yifei Zhao, Tatsuo Yanagita. *Research on prosperity index constructing for maritime transport market*. Proceedings of the International Forum on Shipping, Ports and Airports (IFSPA) 2014, 19-21 May, 2014. 365-375

[6]Albert Wee Kwan Tan，Zhao Yifei，Dali Zhang，Olli-Pekka Hilmola. *State of third party logistics providers in China*, Industrial Management & Data Systems, Vol.114，Iss.9，Oct. 2014，1322-1343

[7]DONG Gang, ZHAO Yifei, *Liner route network evolution in Northeast Asia under the financial crisis*, Journal of Dalian Maritime University, August 2013，

[8]NING Xiao-lin, ZHAO Yifei, CHEN Feier, *Study On Prosperity Indices of Global Shipping Industry*, Journal of Shanghai Jiao Tong University (Natural Science Edition), Vol.47, No.3, March 2013，417-422+427,

[9]Yu Yongli, Zhao Yifei. *Correlation between Tanker Freight and the Price of Spot Crude Oil-Based on Granger Causality Analysis*. Journal of Chongqing Jiao Tong University (Natural Science Edition), Vo1.31, No.5, Oct. 2012，1095-1100,

[10]QING Qian, ZHAO Yifei, *The research and establishment of index of dry bulk shipping market in the world*, Journal of Southwest University for Nationalities (Natural Science Edition), No.2, 2012, 299-304